Falls From Elevation
Best Practice Guide

U.S. Department of Labor
Mine Safety and Health Administration
Directorate of Technical Support

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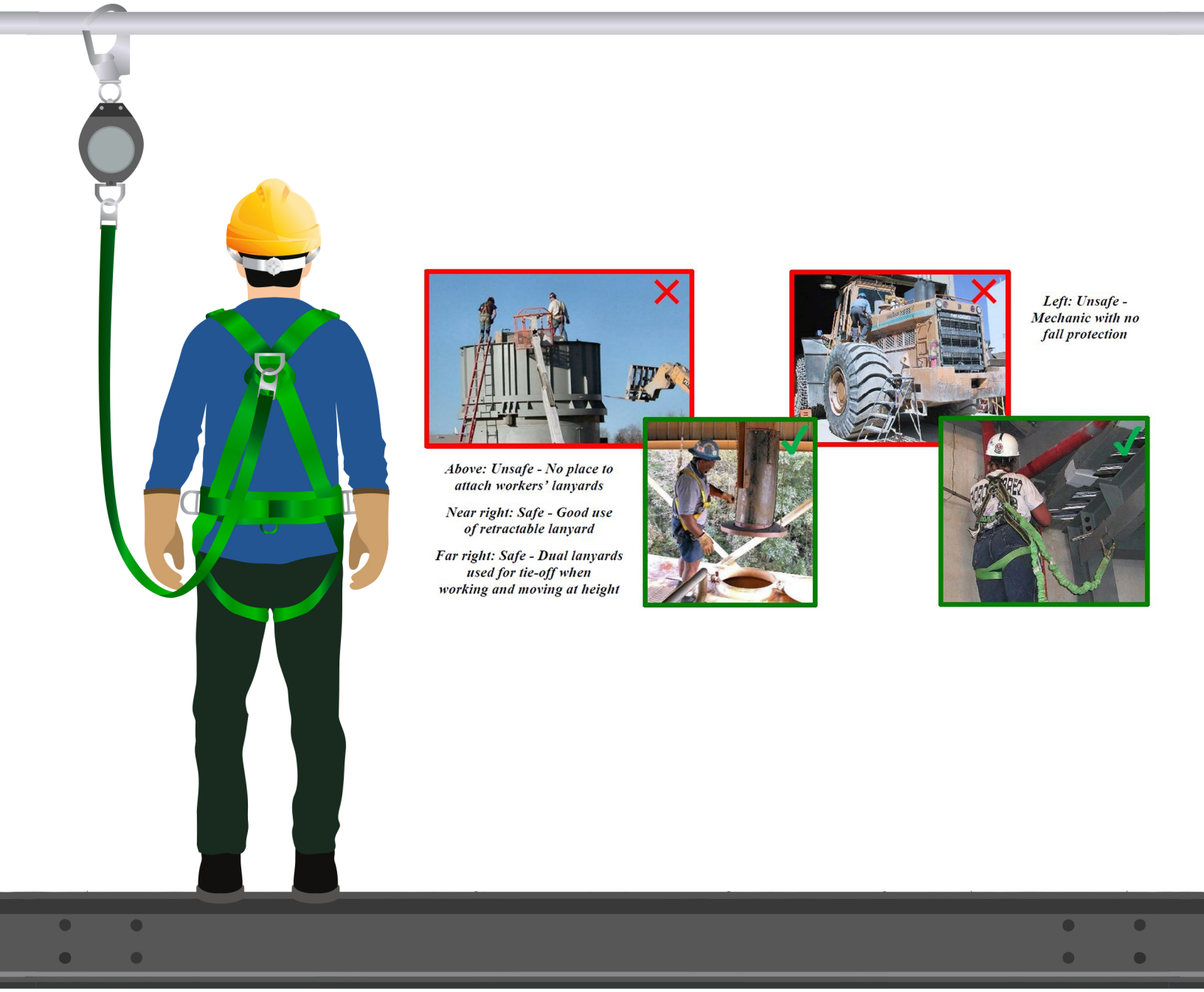


Above: Unsafe - No place to attach workers' lanyards

Near right: Safe - Good use of retractable lanyard

Far right: Safe - Dual lanyards used for tie-off when working and moving at height

Left: Unsafe - Mechanic with no fall protection

U.S. Department of Labor
MSHA
Mine Safety & Health Administration

www.msha.gov

Falls from elevation are a major cause of accidents in the mining industry. MSHA is providing the following Best Practices and compliance assistance information to reduce these types of accidents and fatalities. The contributing factors to the fatalities listed below provide information that allows mine operators and contractors to raise awareness and jointly develop comprehensive fall protection programs.

These contributing factors are:

- Failing to comply with MSHA regulations
- Safe access not provided or maintained in plants and surface facilities
- Safe access not provided or maintained on mobile equipment
- Miners improperly/not tying off
- Falls while getting on and off mobile equipment

MSHA Regulations

In these fall from elevation fatalities, mines have been cited for failing to comply with MSHA regulations. Serious accidents and fatalities may be avoided by complying with the following MSHA 30 CFR regulations regarding fall protection and safe access.

§56/57.15005 Safety belts and lines.

Safety belts and lines shall be worn when persons work where there is danger of falling; a second person shall tend the lifeline when bins, tanks, or other dangerous areas are entered.

§56/57.11001 Safe access.

Safe means of access shall be provided and maintained to all working places.

§77.1710 Protective clothing; requirements.

(g)Safety belts and lines where there is danger of falling; a second person shall tend the lifeline when bins, tanks, or other dangerous areas are entered.

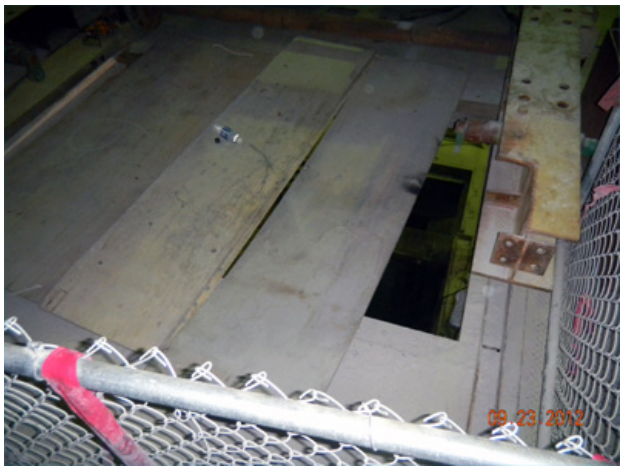
§77.205 Travelways at surface installations.

Safe means of access shall be provided and maintained to all working places.

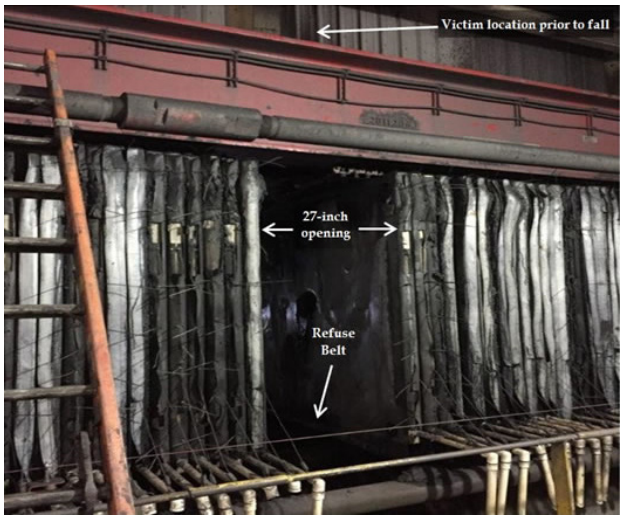
For more information regarding MSHA regulations on travelways and escapeways, click on the following links to 30 CFR **Part 56**, **Part 57**, **Part 75**, and **Part 77**.

Safe Access – Plants and Surface Facilities

Miners have been killed when working in areas they thought were safe. Mine operators need to evaluate and provide protections where there is a danger of falling. In the instances below, safe access was either inadequate or not provided.



METAL/NON-METAL FATALITY - A 34-year-old contract laborer with 6 days of experience was killed when he fell through a 6 ft. x 8 ft. hole that was partially covered with 2" x 4" boards and ¾" thick plywood. He fell into a chute landing on a belt conveyor 30 feet below. The victim was assigned fire watch duties on a welding/cutting operation that was taking place on the floor above him.



COAL MINE FATALITY - A 43-year-old plant attendant, with approximately 13 years of experience, was fatally injured when he fell through a 27-inch opening in a plate press. The victim had climbed a ladder to repair a damaged plate when he fell about 19 feet onto a moving refuse belt. The victim was found in a transfer chute, approximately 55 feet down the belt from where he had fallen.

Best Practices

- Protect and guard all openings through which persons may fall. This includes installing guardrails or barriers around areas where there is a danger of falling.
- Inspect work areas for all potential hazards including places that persons may fall from or through.
- Ensure floor openings are thoroughly covered such that they support weight and movement of miners and equipment in areas of work or travel.
- Ensure that areas are barricaded or have warning signs posted at all approaches if hazards exist that are not immediately obvious.
- Reinstall access covers after traveling or bringing items through an opening.
- Always wear fall protection when there is a danger or potential of falling.

Safe Access Near Water

Additional precautions must be taken to protect miners when working near water. Mine operators should provide appropriate protective equipment, establish safe working procedures and train miners on their use.

METAL/NONMETAL MINE FATALITY – A 27-year old deck hand with 4 years and 8 months of experience drowned at a dredge operation. He was working on a dredge that had a barge attached to it. The victim stepped on the barge and fell into the water.

Best Practices

- Always wear a flotation device where there is a danger of falling into the water.
- Remove snow and ice from work areas.
- Maintain three points of contact.
- Provide communication devices and establish procedures requiring persons to alert coworkers when they are outside the dredge's handrails.
- Install and use lifeline tie-off runs and fall protection.

For more information regarding safe access to plants and surface facilities, see the **Safe Access - Plants and Surface Facilities** section .

There are products known to MSHA that offer a unique solution to provide safe access to miners working where there is a danger of falling. For more information, click here.

Safe Access – Mobile Equipment

Performing routine and non-routine maintenance on mobile equipment can be hazardous. Mine operators need to evaluate each task and provide protections and training when there is a danger of falling from mobile equipment. Risk assessments should be conducted to determine the appropriate fall protection, including barriers, handrails, and personal protective equipment. Mine operators should also consider the use slip resistant material on handrails and travelways.

METAL/NONMETAL MINE FATALITY –
A 27-year-old contract mechanic with 2 years of experience was injured at an underground limestone mine. The victim was repairing a hydraulic pump on a scaler when he fell from an attached walkway approximately five feet to the ground. He was airlifted to a hospital where he died the next day.

METAL/NONMETAL MINE FATALITY –
A 66-year-old contract truck driver with approximately 11 years of experience was killed at a cement operation. The driver was inside a loading rack closing the hatch on top of a bulk tanker truck. When the victim raised the rack to access the hatch, he fell between the rack and rounded side of the truck and then fell to the ground.

Best Practices

- Ensure that persons are trained, including task-training, to address fall from elevation hazards.
- Ensure effective gates, safety chains, or railings are used and properly maintained where openings may exist that could pose a hazard.
- Do not place yourself in a position that will expose you to fall hazards while performing a task.
- Mine operators should evaluate maintenance and production tasks and develop systems and procedures to safely access mobile equipment.

For more information regarding safe access for mobile equipment, see the Safe Access for Mobile Equipment section.

There are products known to MSHA that offer a unique solution to provide safe access to miners working where there is a danger of falling. These include a tanker truck fall protection system, a ground-operated tanker truck manhole cover, and a portable skid-mounted fall protection system.

Tying-off and Proper Use of Fall Protection

Miners have been killed while working from elevations when they were not wearing fall protection or using it improperly. Mine operators need to evaluate and provide fall protection systems when there is a danger of falling.

METAL/NONMETAL MINE FATALITY - A 46-year-old contractor welder was fatally injured at a crushed stone operation. He was preparing to weld on an overhead ventilation duct. The victim was using a ladder to access the duct when he fell over a handrail approximately 45 feet to the ground.

COAL MINE FATALITY - A 53 year-old contract steelworker, with over 16 years of coal mine experience, was killed when he fell approximately 8 feet from a steel beam. He hit a lower cross beam before he landed on a conveyor belt cover located about 32 inches below the cross beam. The victim had been engaged in cutting operations just prior to the fall, and was repositioning when he removed his lanyard tie-off safety device from the location where it was secured.

Best Practices

- Wear and use fall protection, maintaining 100 percent tie off, when fall hazards exist.
- When using a ladder, ensure stability and use three points of contact when climbing.
- Ensure that persons are task-trained and understand the hazards associated with the work being performed. This includes proper use of their personal protective equipment.
- When working in bins, silos, hoppers, and tanks ensure persons are properly tied-off, with one line tender per person.

For more information regarding tying off and fall protection, click here.

For a printable poster regarding tying off and fall protection, click here.

There are products known to MSHA that offer a unique solution to provide safe access to miners working where there is a danger of falling. For more information, click here.

Ingress and Egress from Mobile Equipment

Fatalities can occur when miners fall while getting on and off mobile equipment. Mine operators need to maintain manufacturer provided access systems and train miners on their use. The instances below demonstrate the importance of maintaining "three points of contact" when mounting and dismounting equipment.

COAL MINE FATALITY – A 52-year-old rock truck operator with over 13 years of mining experience fell from the truck he operated while attempting to ascend the access ladder to the operator's cab. He later died of complications from the injuries sustained in the fall.

METAL/NONMETAL MINE FATALITY –
A 59-year old delivery truck driver with 32 years of experience was killed at a cement plant. The victim arrived at the plant to deliver drums. After opening the trailer doors, the driver walked to the cab of his truck and proceeded to climb the steps to get back in the cab when he fell backwards onto the ground striking the back of his head.

Best Practices

- Always use the "Three Points of Contact" method. Ensure that either two hands and one foot, or one hand and two feet are in contact with the ladder at all times when mounting and dismounting equipment.
- Equipment should be designed to minimize the height of the first step from the ground and be provided with hand-holds to facilitate "Three Points of Contact"
- Keep hands free of any objects when mounting or dismounting equipment.
- Maintain traction by ensuring hands and footwear are free of potential slipping hazards such as dirt, oil, and grease. Slip resistant material can be coated to existing foot holds and handrails.
- Always face equipment when mounting or dismounting it.
- Always maintain and use the access provided by the manufacturer.

For more information regarding ingress and egress from mobile equipment, see the expanded Ingress and Egress from Mobile Equipment section further down in this document.

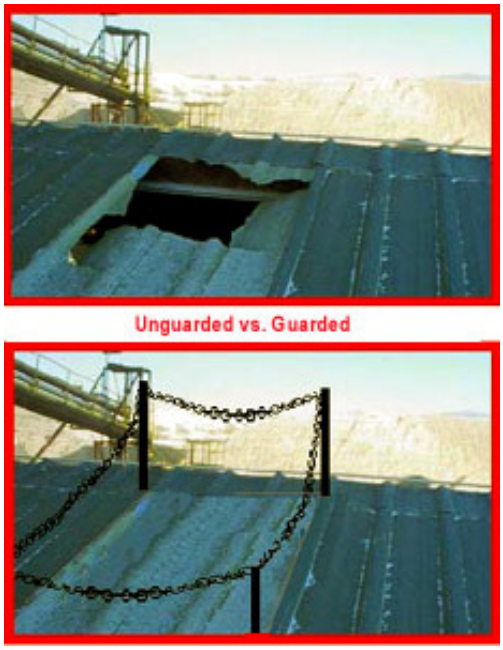
There are products known to MSHA that offer a unique solution to provide safe access to miners working where there is a danger of falling. For more information, click here.

Safe Access – Plants and Surface Facilities

Guardrails, Barriers and Floor Covers

- Inspect the work areas for all potential hazards including places that persons may fall from or through.
- Take time to plan the work to safely perform the job.
- Always wear fall protection when there is a danger or potential of falling.
- Protect floor openings and leading edges near travel ways by installing guardrails or barriers in addition to warning signs.
- Keep temporary access opening covers or railings secured in place. Immediately reinstall access covers when not bringing items through the opening.

Skylight Guarding



A miner sent us this safety idea after reviewing a Fatalgram where a maintenance worker fell through a roof skylight. He noted "there should have been a guard around the skylight. I know where I work we have guards around every one of our skylights. I believe they are about 42 inches in height. This keeps a person from walking onto the skylight or backing onto the skylight.

The skylights have a way of getting dirty and then you don't notice them. They can be mounted even on a pitched roof. They can be bolted down to the roof or if the roof isn't strong enough a frame can be built that is strong enough to hold the skylight." This is good advice. Another idea is to raise the skylight so it is not flush with the roofline. Not everyone who goes into an area will be aware of the hazards. This is especially true if the area is seldom used or if that person has never been on that site.

If a surface is not specifically engineered and constructed to serve as a walkway, access should be restricted, and warning signs posted. Also, if access is possible, provide proper fall protection for workers that will be exposed to the hazards of elevated work areas.

Illumination

As the days grow shorter, start-up, shut-down, and maintenance can be performed in the dark. Consider the use of lights that hook on an elastic strap or clips to the bill of a hard hat. They are lightweight, simple to use, and eliminate the need for extension cords and portable lights. As opposed to using hand held flashlights both hands are able to be used while performing maintenance work and getting on and off equipment.

Plants and surface facilities should provide adequate lighting in areas where miners travel and where work is being performed. This includes stairs, walkways, and ladders.

Maintenance

While running conduit in a preparation plant, an electrician fell into an operating cyclone sump while working from a perforated plate screen that covered the top of the sump. The fatal accident occurred when a section of the screen gave way under the weight of the worker. The purpose of the screen was to keep extraneous material from getting into the sump. The screen was not designed or intended to be walked upon and over time it had been weakened by corrosion. There was an access ladder to the top of the sump, but it was only intended to provide a vantage point for checking the pumps and pipes.

To prevent such accidents, mine operators should do the following:

- Where persons need to work above a sump or other open vessel, provide a safe means of access.
- Beware of situations where a worker may assume that it is safe to walk on a cover that is not intended or engineered to support their weight.
- Where a cover on a sump or other open vessel is not designed or intended to support personnel, make sure that warning signs are provided and access blocked.
- Where safe walkways are not available for performing maintenance activities, ensure that workers use appropriate fall protection.
- Check with the vessel manufacturers on what options they can provide for safe access. Manufacturers can provide covers of corrosion-resistant material, such as stainless steel, designed to safely support the weight of personnel.
- Ensure that elevated walkways are engineered with adequate strength and provided with proper guardrails.
- Check walkways regularly for corrosion or other damage that would make them unsafe.
- Shut down sumps when performing maintenance activities in or around them.

Work Platforms

Workers have been seriously injured when falling from platforms or ladders. An accident potential exists when the landing area of a ladder is near the entrance to the top landings of stairways. Factors creating this potential include individuals being required to "back" down the ladder and unable to see the stairway opening.

The natural act of stepping backwards upon reaching the platform can result in a fall down the stairs. These types of accidents can be prevented by not locating ladder landing areas across from top landings of stairways or, by installing a self-closing gate or guard across the opening at the top of the stairs. The gates must remain closed at all times. A single careless act of leaving the gate open could negate the good plans of prevention. A self-closing device on the gate and a sign to alert workers to keep the gate closed should help to ensure the protection is always present.

Work Platforms – Cranes or Derricks

MSHA recommends using the following safety equipment and practices when working from platforms suspended by Cranes or Derricks:

- Use a full body harness with the lanyard secured to the suspended platform or above the crane hook or ball.
- Inspect the crane or derrick prior to suspending a work platform. This should include inspection of the wire rope, hoist drum brakes, boom and other mechanical and rigging equipment vital to the safe operation of the crane or derrick.
- Use a work platform approved by a qualified engineer and rigging approved by a qualified person.
- The platform should be equipped with an access gate. The access gate should swing inward, and should be equipped with a positive locking latch.

- Platform perimeter protection should consist of:
- A top rail approximately 42 inches above the floor,
- A toe board at least 4 inches high, and
- A midrail approximately halfway between the top rail and the toe board.
- The platform is to be positively locked to the load block or hook in a manner that prevents accidental disengagement.

Highwalls

When working near a highwall where a fall is possible a person must be tied-off

- Examine highwall face from the bottom and then from the top
- Check for cracks from the top.
- Beware of the "Danger Zone" which is 6ft from the edge or 6ft from unstable ground
- For fall arrest use full body harness and shock-absorbing lanyard
- The Line should be shorter than the distance from the crest to the tie-off point
- Examine the equipment including the harness, lanyard, connecting snaps, and d-rings for damage.
- Tie-off to a T-Bar or mobile equipment parked parallel to the face with the brakes set and wheels chocked
- Do not tie-off from the drilling rig itself.
- Always use fall protection equipment according to manufacturer's recommendations.

Use Ladders and Stairs Safely

- Be sure all ladders are in safe working order before using them
- Secure and stabilize all ladders before climbing them
- Never stand on the top rung or step of a ladder
- Use handrails when going up or down stairs

Portable Ladders

Be Aware

- First, read all ladder labels and markings; follow all instructions.
- Avoid electrical hazards—look for overhead power lines or exposed, energized electrical equipment.
- Inspect the ladder before use. If it is damaged, remove it from service and discard it or tag it until repaired.
- Know the ladder's maximum load rating, and be sure the weight it supports (you, tools, supplies, etc.) does not exceed that rating.
- Be sure no slippery material is present on you or the ladder.

Place and Use Properly

- Use ladders and appropriate accessories (ladder levelers, jacks, or hooks) only for their designed purposes.
- Do not use a self-supporting ladder, such as a folding stepladder, as a single ladder or in a partially closed position.
- Place a ladder only on a stable and level surface, unless it has been secured at the top and bottom to prevent displacement.
- Do not place a ladder on boxes, barrels, or other unstable bases.
- Be sure an extension or straight ladder extends at least three feet above the point of support. Do not stand on the top three rungs.
- Place the ladder at the correct angle. The distance of the base from the point directly below the point of support should be one quarter the height of the point of support.
- If there is potential for the ladder to be bumped or moved while in use, secure it to prevent movement or erect a barricade to keep traffic away from the ladder.
- Be sure that all extension ladder locks are properly engaged.

Climb and Stand Properly

- Keep your body near the centerline of the ladder.
- Do not move or shift a ladder while someone is on it.

Safe Access for Mobile Equipment

Accessing, operating or maintaining self-propelled mobile equipment often requires activities such as climbing ladders, or walking on machinery surfaces which expose miners to hazard such as falls during all types of weather conditions. Modern mobile equipment is designed to minimize slip and fall hazards; but, large machinery, new and old, can require access at heights with a fall potential that can cause serious injury. The following precautions can reduce slip and fall accidents from mobile equipment.

- Walkways should be no narrower than their original manufactured widths, constructed with slip-resistant surfaces, and securely attached. Unobstructed access should be provided to all areas of the machine where a person might travel.
- Handholds or handrails should be within easy reach at critical locations.

Inspection and Maintenance

- Inspect contact areas for slip or trip hazards.
- Ensure steps and handrails are properly secured and free of defects and debris.
- Ensure landing areas are equipped with adequate lighting.

To eliminate slips and falls while tarping loads use an old flatbed trailer equipped with handrails around the bed. Park this flatbed in an open area and put a set of stairs against it. Trucks and trailers to be tarped can be pulled directly alongside the trailer with handrails to cover their loads.

Tying-off and Proper Use of Fall Protection

- Developing a Successful Fall Protection Program - 5 Basic Elements
- Understand Your Fall Arrest System
- Calculating Fall Clearance
- Lanyards – the Critical Link in Fall Protection
- Self-Retracting Lifelines (SRL)
- Fall Protection Equipment Selection Considerations

Developing a Successful Fall Protection Program – 5 Basic Elements

1. Understanding Regulations and Standards
2. Hazard Identification
3. Pre-Planning & Written Fall Protection Plan
4. Product Selection
5. Training

1. Understanding Regulations and Standards

Understanding these requirements is key to ensuring a safe working environment.

- (30 CFR 56.15005 or 57.15005 – safety belts and lines)
- (30 CFR 77.1710(g) – safety belts and lines)

2. Hazard Identification

A well-conceived fall protection program begins with identification of all fall hazards in the workplace.

In mining operations, personal fall protection equipment is required any time there is a danger of falling. This includes working in bins, tanks or other dangerous areas where a second person shall tend a lifeline while miners work in these areas.

Where a fall hazard exists, there are two acceptable options:

- eliminate the hazard, or
- provide protection against it.

Ideally, it is best to totally eliminate the hazard. If not possible other measures such as the wearing of personal fall protection equipment (PPE) are required.

3. Pre-Planning & Written Fall Protection Plan

A written program should be developed specifying how to deal with each identified hazard. The plan should state:

- what fall protection measures are to be used
- how they are to be used
- who is responsible for overall supervision and training

4. Product Selection

The employer must know the types of fall protection products that are available, and decide which would be most suitable for the workplace.

Because all work environments differ, it is impossible for the manufacturer to determine exactly which fall protection products will provide maximum protection for each job.

By understanding how fall protection products operate and knowing the differences in product functions, the employer can select products that are best suited for its workers

5. Training

To maintain a safe work environment, it is essential that persons are properly trained to:

- Recognize potential fall hazards
- Evaluate the risk posed by each hazard
- Control the hazard with preventive or protective measures
- Determine which products to use in specific work environments
- Demonstrate proper anchoring procedures, etc.
- Learn inspection and maintenance procedures
- Properly wear fall protection equipment including size, fit and adjustment

Understand Your Fall Arrest System

A Personal Fall Arrest System is comprised of three (3) key components – anchorage connector; body wear; and connecting device.

Remember: A, B, & C

- **A = Anchorage/Anchorage Connector**
- **B = Body Wear**
- **C = Connecting Device**

A = Anchorage/Anchorage Connector

Anchorage: Commonly referred to as a tie-off point (Ex: I-beam, rebar, scaffolding, lifeline, etc.)

- Must be high enough for a worker to avoid contact with a lower level should a fall occur.
- Anchorages must be capable of supporting 5,000 pounds (22kN) of force per worker.
- Careful consideration should be given to selecting a proper anchorage for ultimate safety.
- The anchorage should be easily accessible.

The Importance of Anchorages

Carefully planned and selected anchorages are crucial. Should a fall occur, the worker will be suspended from the anchorage, their life depending on its strength? An anchorage, for example, could be an I-beam, while a cross-arm strap, or choker, wrapped around this beam and permitting attachment is the anchorage connector. Anchorage Connectors are designed as the intermediary device for securing a connecting device to an anchorage. The anchorage connector should be positioned to avoid a "swing fall."

Examples of Permanent Anchorage Connectors

Examples of Temporary Anchorage Connectors

Temporary Horizontal Lifeline Systems

Leading Edge Anchorage Connector

Beam Anchorages

B = Body Wear

Body Wear: The personal protective equipment worn by the worker (Ex: full-body harness). The only form of body wear acceptable for fall arrest is the full-body harness. The body wear should be selected based on the work to be performed and the work environment. Side and front D-rings are for positioning only.

Premium Harness

Incorrect Harness Fit*

*Chest strap positioned incorrectly. Should be located at mid-chest to keep shoulder straps snug. Leg straps are too loose.

Incorrect Harness Fit

Correct Harness Fit*

*Chest strap positioned too high and too loose. Leg straps are positioned improperly.

C = Connecting Devices

While focus is given to anchorage connectors and body wear (full-body harnesses) components, the **connecting device** (a shock-absorbing lanyard or self-retracting lifeline) between these two components actually bears the greatest fall forces during a fall.

Shock-Absorbing Lanyard or Self-Retracting Lifeline - Always know your fall distance and select proper equipment to meet the fall clearance.

- **UNDER 18 1/2 ft. (5.6m)** - Always use a Self-Retracting Lifeline.
- **OVER 18 1/2 ft. (5.6m)** - A Shock-Absorbing Lanyard or Self-Retracting Lifeline can be used.

Calculating Fall Clearance

Select the Proper Fall Protection Equipment.

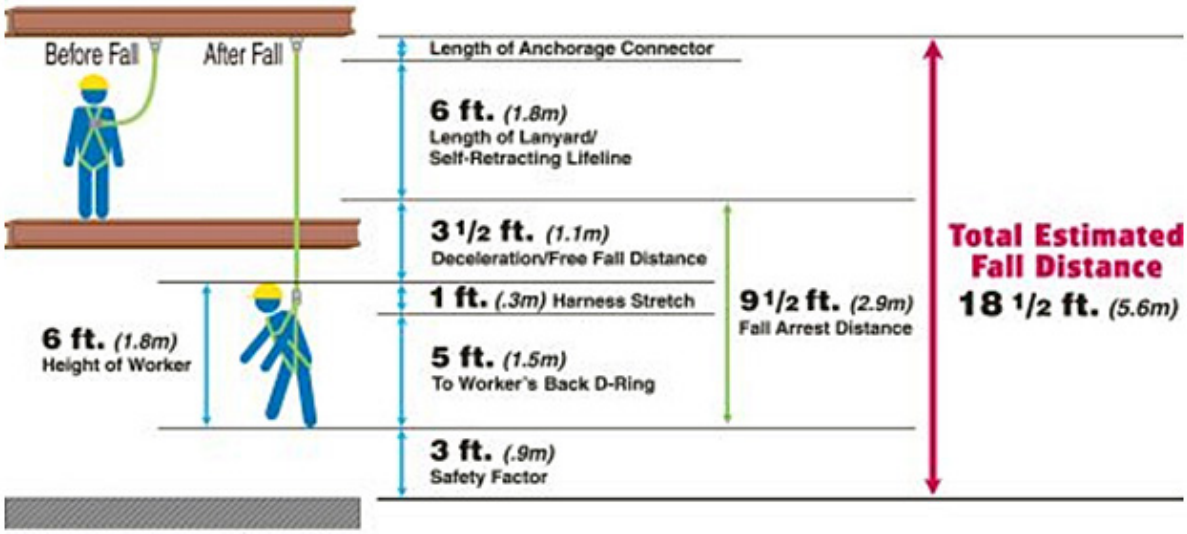


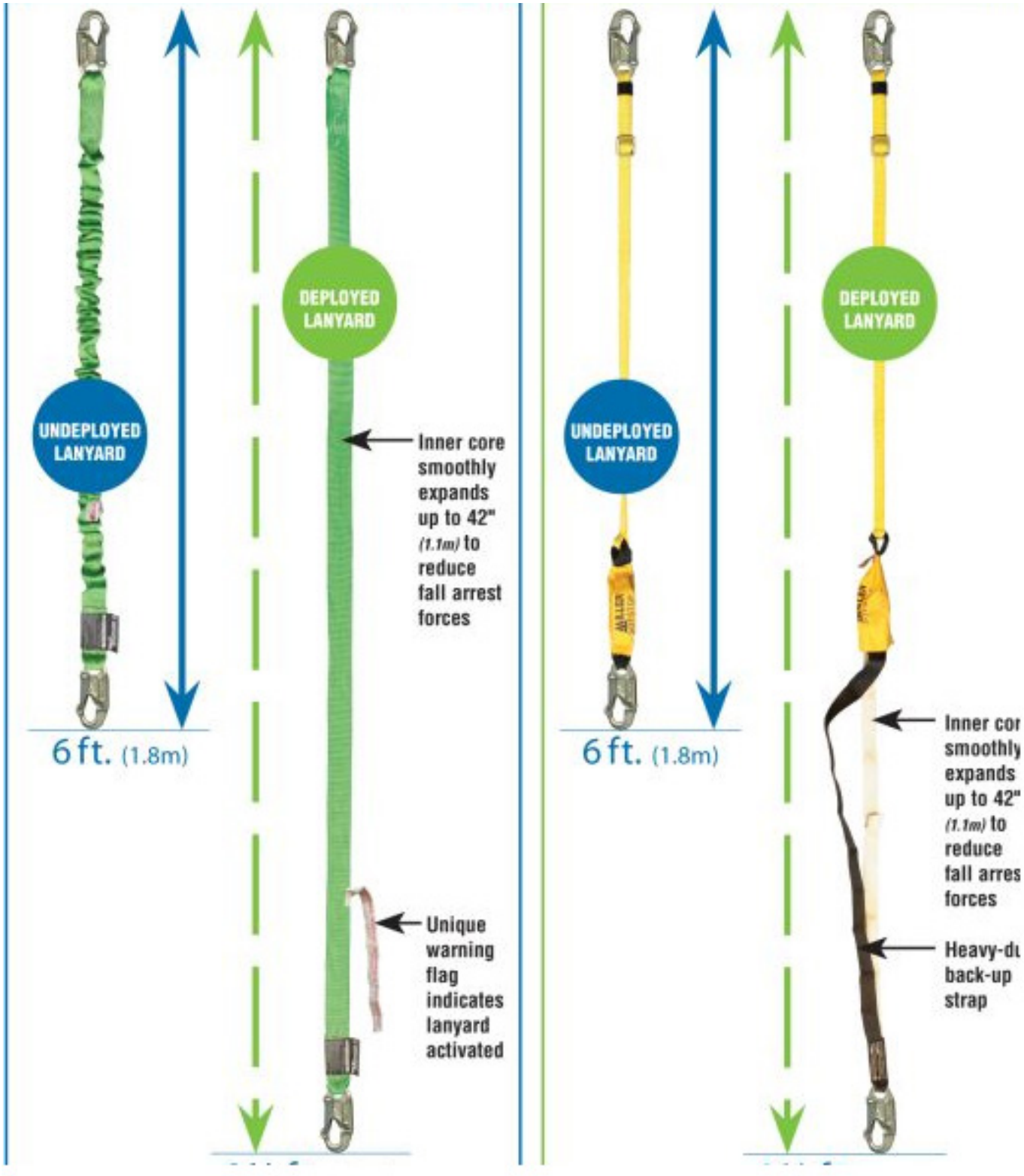
Illustration: 6 ft. (1.8m) Shock-Absorbing Lanyard with D-Bolt Anchorage Connector

Lanyards – the Critical Link in Fall Protection

The lanyard is a connecting device, a flexible line to secure a full-body harness or body belt, where permitted, to a point of anchorage. There are two basic categories of lanyards: non-shock-absorbing and shock-absorbing. The more common and safer type is the shock-absorbing lanyard.

- Shock-absorbing lanyards extend deceleration distance during a fall, significantly reducing fall arresting forces by 65 to 80 percent, below the threshold of injury.
- One type of lanyard includes a special shock-absorbing inner core material surrounded by a heavy-duty tubular outer jacket that doubles as a back-up web lanyard.
- MSHA recommends lanyards that are self-closing with self-locking snap hooks to reduce the possibility of unintentional disengagement, or “rollout”.

Shock-Absorbing Lanyards – Before and After Deployment



HAZARD ALERT!

NEVER Tie-Back (choke off) with a standard/ conventional lanyard!!!

Conventional lanyards cannot be tied back for 3 reasons:

- Lanyard strength is weakened by at least 30% (i.e. similar concept of reduced strength in rigging due to sling load angle used to lift materials or equipment).
- Conventional Lanyards can be damaged, frayed, or cut when dragged over beams or other structure.
- Conventional Snap Hook Gates could open or break since they are designed for 350 # of force.

Solution: Use specially designed lanyards with heavy-duty webbing for more abrasion resistance and 5,000 # snap hook gates OR use conventional anchorage connection devices such as a cross-arm strap.

Self-Retracting Lifelines (SRL)

FALL LIMITERS are lightweight, web retractable that requires less fall clearance, offer greater mobility and prevent tripping hazards.

A Shock-Absorbing Lanyard or Self-Retracting Lifeline can be used for fall clearances **OVER** 18 1/2 ft. (5.6m)

SELF-RETRACTING LIFELINES (SRLs) are durable and dependable heavy-duty retractable available with webbing or cable.

Always use a Self-Retracting Lifeline (SRL) for fall clearances **UNDER** 18 1/2 ft. (5.6m)

(Shock-Absorbing Lanyards or Self-Retracting Lifelines) If involved in a fall while using a shock-absorbing lanyard or self-retracting lifeline, and with an anchorage point that is not positioned directly overhead, a swing fall or pendulum effect will occur. Striking an object while swinging can lead to serious injury.

Since self-retracting lifelines allow for greater horizontal and vertical mobility than standard six-foot shock-absorbing lanyards, extra care should be taken to reduce swing falls.

Whether using shock-absorbing lanyards or self-retracting lifelines, it is very important to position your anchorage point directly overhead whenever possible to minimize swing falls.

When stopping a fall, a personal fall arrest system must:

- Limit maximum fall arresting force on an employee to 1,800 pounds (8kN) when used with a full-body harness;
- Limit free fall distance to less than 6 feet (1.8m), and be rigged in such a way as to prevent contact with a lower level;
- Bring the employee to a complete stop while limiting maximum deceleration distance to 3-1/2 feet (1.1m); and
- Have sufficient strength to withstand twice the potential energy of a worker free-falling from a distance of 6 feet (1.8m) (or the free-fall distance permitted by the system, whichever is less).

Fall Protection Equipment Selection Considerations

To select the appropriate lanyard for a specific application, consider the following factors:

- **The type of work being performed and the specific conditions of the work environment.** This includes the presence of moisture, dirt, oil, grease, acids and electrical hazards, as well as the ambient temperature. For example, steel cable lanyards are particularly strong, heat resistant and durable; however, they are not suitable for use around high-voltage sources because they readily conduct electricity.

- **Potential fall distance.** This distance is greater than most people think, consider: the length of the lanyard, the length that the shock absorber will elongate during deceleration, the height of the worker, plus a safety factor.

- **The compatibility of system components.** A personal fall arrest system should be designed and tested as a complete system. Components produced by different manufacturers may not be interchangeable.

Selection criteria also should include a scrutiny of product quality.

ANSI Z359 standards for equipment manufacturers suggest that non-shock-absorbing lanyards limit fall forces to 1,800 pounds (8kN), an infeasible option with commercially available lanyard materials, and 900 pounds (4kN) for shock-absorbing lanyards.

Most reputable lanyard manufacturers design to the 900-pound (4kN) standard, and state this on the label of the lanyard. ANSI standards are self-enforced by individual manufacturers – there is no enforcement body, and no inspectors. Thus, the buyer cannot take stated performance per ANSI guidelines for granted.

General Fall Protection Considerations

- **Warnings –** Always read all instructions and warnings contained on the product and packaging before using any fall protection equipment.
- **Inspection –** All fall protection equipment must be inspected prior to each use.
- **Rescue Planning –** Minimizing the time between a fall occurrence and medical attention of the worker is vitally important. A thorough rescue program should be established prior to using fall protection equipment.
- **System Components –** Only components that are fully compatible with one another should be used. Fall arrest systems are designed and tested as complete systems and should be used in this way.
- **Product/System Details/Questions –** Always contact a reputable manufacturer.
- **What to do after a fall –** After a fall occurs; all components of the fall arrest system should be removed from service.

Learn More: Personal Fall Arrest Equipment Task Training Guide

*Photos/Illustrations/Information courtesy of Miller® Fall Protection

Ingress and Egress from Mobile Equipment

Each year miners are injured getting on or off equipment. Special measures can be taken to improve footing or ladder design to improve the situation.

MSHA suggests the following:

- Newer self-cleaning ladders can be installed. The steps have raised perforations that allow material to be pushed through.
- Where possible, install stairways in lieu of vertical ladders.
- Slip resistant material can be coated to existing ladders, handrails and landings.
- Additional handholds and access lighting can be installed.
- Footwear with slip resistant design can be used.
- Steps should be highly visible and easily reached by all persons.
- Always maintain three points of contact when getting on or off equipment.

Existing mobile equipment should be analyzed for field improvements to include any of the above suggestions. New equipment specifications should include ingress/egress engineering improvements such as the above mentioned.

Accessing, operating or maintaining self-propelled mobile equipment often requires activities such as climbing ladders, or walking on machinery surfaces which expose miners to hazard such as falls during all types of weather conditions. Modern mobile equipment is designed to minimize slip and fall hazards; but, large machinery, new and old, can require access at heights with a fall potential that can cause serious injury.

The following precautions can reduce slip and fall accidents from mobile equipment:

- Equipment should be inspected for icy, wet, or oily areas at the start of each shift and whenever conditions dictate.
- Before climbing on, off or around mobile equipment, footwear should be free of mud or other substances that could cause slipping.
- Persons climbing on or off mobile equipment should face the machine.
- Both hands should be free for gripping the ladder, handrail, or handhold.
- When necessary, a cord, rope, or other line should be used to lift and lower lunch pails, thermos bottles, or tools.

Prevent Slip and Falls

A high number of accidents at surface mines are due to slips and falls from equipment due to mud and ice buildup. An easy way to clean mud from the steps of a front end loader or other equipment is to carry a small garden hand spade in a large zip lock bag. It can fit into a lunch box or lunch tote. Remove the small spade from the zip lock bag, clean the steps, return the spade to the zip lock bag and store it. At times a shovel may not be readily available and this small spade will do the job rather quickly and it is convenient to carry along and it may prevent a slip or fall.

Foul weather magnifies these hazards. It takes very little ice, rain or mud to make the climb much more hazardous. If the equipment operator has to carry a lunch box, water jug, tool kit, logbook, or other objects up the steps, the hazards increase.

1. Mount a "Bad Weather Box" near the steps and accessible from the ground. The weather-proof box should contain at a minimum:
   - A pair of cotton gloves for a better grip on wet or icy handrails,
   - A flashlight for the walk around inspection at night or in gloomy weather,
   - Paper towels

If the space in the box permits, a can of de-icer, and even a bottle of glass cleaner for mirrors, windows, or camera lenses could be added.

2. Attach a "Dog Leash" to a rail for lifting lunch boxes, water jugs, tool kits, etc. Make the line long enough so that the end is also accessible from the ground. This will allow the operator to use both hands on the rails (maintain three points of contact) while climbing the steps, a good idea regardless of the weather. A plastic coated clothes line with a dog leash type snap works well for this application. After the operator reaches the deck of the machine, the gear can be pulled up with the leash and connect the free end to the top eyebolt. At the end of the shift the operator can lower the gear and reconnect the free end of the line to an eye-bolt anchor at the ground level, ready for the next operator.

Three Points of Contact

- Use either two hands and one foot, or one hand and two feet when mounting and dismounting equipment. Failure to use this method has resulted in numerous serious injuries.
- Keep hands free when making three points of contact.
- Maintain traction by ensuring footwear is free of potential hazards such as dirt, oil, and grease.
- Use hoisting materials to transport tools and other objects that may keep hands from being free.

Proper Approach

- Always face equipment when mounting or dismounting.
- Always use the access provided by the manufacturer.
- Identify all potential tripping and falling hazards before working
- NEVER jump from any height

Innovative Products for Fall Prevention

MSHA has reviewed information from manufacturers of these products and believes they have the potential to reduce certain hazards. MSHA does not endorse any of these products nor their manufacturers. Although information has been reviewed by Technical Support Engineers, these products have not been tested nor approved by MSHA. Some products are new, while others have been used for some time either in mines or in industries other than mining. Because each mine has unique conditions and features, mine operators should evaluate or test a product's potential to reduce certain hazards at their mines before using any product.

100% Tie-Off Fall Protection System

100% tie-off systems that incorporate self-retracting lanyards (SRL) with innovative mounting brackets attached to the harness back D-ring are now available. These systems may be an alternative for conventional double lanyard systems often referred to as “double leg”, “twin tail”, or “Y-lanyards” for 100% tie-off.

Remember these lanyards were designed to allow you to stay protected (100% tie-off) while you move from one location to another (Examples may be transitioning from a man lift to a roof top, climbing vertically or from vertical structural steel to a horizontal structural steel lifeline.).

In an alternating or “leap-frog” fashion the user attaches one SRL to an anchorage point, moves to a new location, attaches the second SRL, then disconnects the first SRL and moves again. An advantage of using double SRLs versus conventional double legged shock absorbing lanyards is maintaining a shorter fall distance and eliminating the need for different fall protection equipment to address changes in fall clearance.

A Tanker Truck Fall Protection System

An innovative moveable fall protection safety restraint system provides safe access for drivers and miners working on top of tanker trucks and stationary tanks.

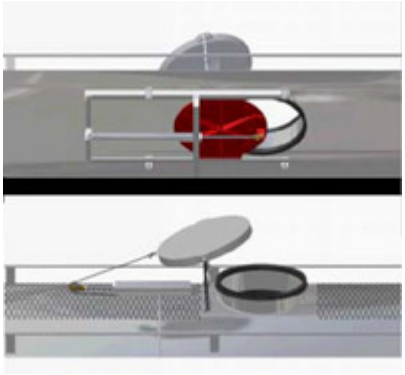
The new approach ensures workers are firmly attached to the system at all times. Personnel can safely move from the tanker access ladder to the tanker top then along the top of the tanker to any point along its length. The system provides a safety restraint belt/harness with a handhold and solid anchor that moves along a rail with the user.

Professionally engineered systems have been designed with the following features:

- A standalone system that operates independently of air or electrical systems.
- Easy for drivers/miners to use.
- Constructed of strong, lightweight, corrosion resistant materials.
- Ease of installation on existing or new tankers.
- Simple to clean and maintain.
- Drivers/miners can perform work with minimal equipment interference.

Ground-Operated Tanker Truck Manhole Cover

Miners have been fatally injured in slip and fall accidents while accessing tanker truck manhole covers. The task of accessing tanker trailers becomes extremely hazardous when adequate fall protection is not provided and when working in windy and inclement weather conditions. To eliminate the falling hazard, innovative pneumatically actuated ports for dry bulk trailers are available to keep drivers/operators safely on the ground.



This equipment can be designed with the following features:

- A pneumatically actuated weather cap to cover the manhole opening preventing contamination of the lid operating area and the load.
- Weather caps and internal lids designed for pressurized and non-pressurized tank applications.
- Retrofit capability for new and existing trailers.
- Non-corrosive materials and high-grade gasket materials to eliminate lid failure due to environmental conditions.
- Control panel design for safe convenient/accessible locations on the ground.
- Switch activated single valve operation for both weather caps and internal lids.

A Portable Skid-Mounted Fall Protection System

A portable skid-mounted fall protection system can provide a practical solution to protect miners while servicing and maintaining mobile and stationary equipment. Systems should be designed to be towed or carried to provide quick and safe fall protection wherever needed.

Systems should be designed with the following features:

- Deflection-free fall arrest performance to eliminate secondary fall-related injuries.
- Coverage to allow workers to traverse a protected area the width and length of the entire machine.
- Counterweight capability should be provided by loading a ballast box/area with gravel or stone.
- Systems should include a trolley, carabiner, high strength non-corrosive self-retracting lifeline and safety harness.

Folding Portable Truck Bed Ladders

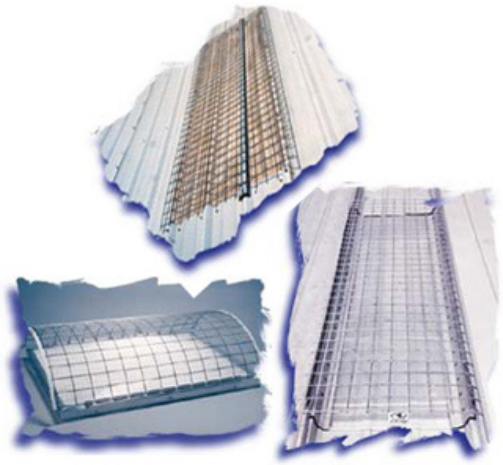
Using a portable ladder is one option to avoid accidents/injuries caused when miners fall while accessing or when jumping off of truck beds. Portable folding ladders are available to adapt to flatbeds, vans, and straight truck beds.

The ladders should be professionally engineered and designed with the following features:

- Slip resistant/anti-skid steps
- Non-pinching hinges
- Mounts at appropriate working angle (i.e. 22 degrees)
- Handhold/handrail features
- Constructed of strong light weight material for portability and ease of handling/stowing
- Appropriate working load capability

Skylight Screen Guard

To prevent falls through acrylic dome and corrugated fiberglass skylights, manufacturers have developed screen safety guards. Properly installed skylight screen guards can completely eliminate the hazard of falling through a skylight. Regular corrugated fiberglass skylights and trapezoidal standing seam skylights are especially hazardous since they are at the same level as the roofing and have the same profile. Dirt and debris can camouflage skylights.



Skylights are easily overlooked when personnel are accessing, working or walking on the roof. Screen guarding can be specifically designed to prevent falls through many types of skylights.

Note: Mounting hardware should be corrosion resistant and designed specifically for each skylight system.

For information on manufacturers that are known to MSHA to have such products available, contact MSHA's Applied Engineering Division at 304-547-0400 or email InnovativeProducts@dol.gov.

Prevent Fall Accidents

U.S. Department of Labor
MSHA
Mine Safety & Health Administration

Know Your ABCs

Anchorage
A tie-off point capable of supporting 5,000 lbs

Connecting Device
A shock-absorbing lanyard or self-retracting lifeline between these two components

Body Wear
A full-body harness worn by a worker

*Photos/Illustrations/Information courtesy of Miller® Fall Protection

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