



WICHITA STATE  
UNIVERSITY

# Preventing Slip and Fall Accidents at WSU

---

G. Miller, F. Plummer, and E. Asmatulu

Department of Environmental Health and Safety  
Wichita State University

April 21, 2014

# Related Videos

- OSHA Hazards: Fall Protection (11:27 min) <https://www.youtube.com/watch?v=z62qFhT3a4>
- 5 Things You Need to Know About Post Fall Rescue (5:18 min) <https://www.youtube.com/watch?v=AMQAWzJO4pl>
- OSHA ANSI Fall Protection Safety (26:13 min) <https://www.youtube.com/watch?v=K3nc4rll97s>
- Fall Protection Harness Donning - Part 1 (3:22 min) <https://www.youtube.com/watch?v=tdfM16NtoQc>
- Fall Protection Harness Donning - Part 2 (1:21 min) <https://www.youtube.com/watch?v=oMlbTiZ1M6l>
- Fall Protection Harness Donning - Part 3 (1:01 min) <https://www.youtube.com/watch?v=tBPYwvfNhmQ>
- Chapter 1- Thinking about fall protection (2:15min)  
<https://www.youtube.com/watch?v=GpXqi9Jyff8&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 2- Facts about Fall Protection (2:56min)  
<https://www.youtube.com/watch?v=39jh4dnO3js&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 3- Hierarchy of Fall Protection (1:15min)  
<https://www.youtube.com/watch?v=2Ueq95L7yPA&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 4- Fall Protection Basics (3:23min)  
<https://www.youtube.com/watch?v=-YMNZm72bZw&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 5- ABCD's of Fall Protection (1:53min)  
<https://www.youtube.com/watch?v=opt4JkJclHs&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 6 - Fundamentals of Fall Protection (1:46min)  
<https://www.youtube.com/watch?v=qKtPRfnOIUc&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 7 - Calculating Your Fall Distance (4:18min)  
<https://www.youtube.com/watch?v=0UtRR4Eqmil&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 8 - Types of Falls (2:52min)  
<https://www.youtube.com/watch?v=shsp3Yt1HKA&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 9 - Components of a FAS (6:11min)  
<https://www.youtube.com/watch?v=hpXkaJGXJ5k&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>
- Chapter 10 - Equipment Inspections (1:36 min)  
[https://www.youtube.com/watch?v=tyYr6\\_gB3RI&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj](https://www.youtube.com/watch?v=tyYr6_gB3RI&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj)
- Chapter 11 - Thinking About Fall Protection(1:13min)  
<https://www.youtube.com/watch?v=Wjy3n5edbAM&list=PLvOuh0MmS-LNfnpj4HomecOgb3D842Wdj>

# Introduction

- According to Occupational Safety and Health Administration (OSHA), each year, on average, between 150 and 200 workers are killed and more than 100,000 are injured as a result of falls at construction sites.

Standard for fall protection deals with both the **human** and **equipment-related** issues;

## **Employers and employees need to follow:**

- Where protection is required
- Use proper construction and installation of safety systems
- Supervise employees properly
- Use safe work procedures
- Train workers in the proper selection, and maintenance all protection systems.

# Scope of Training

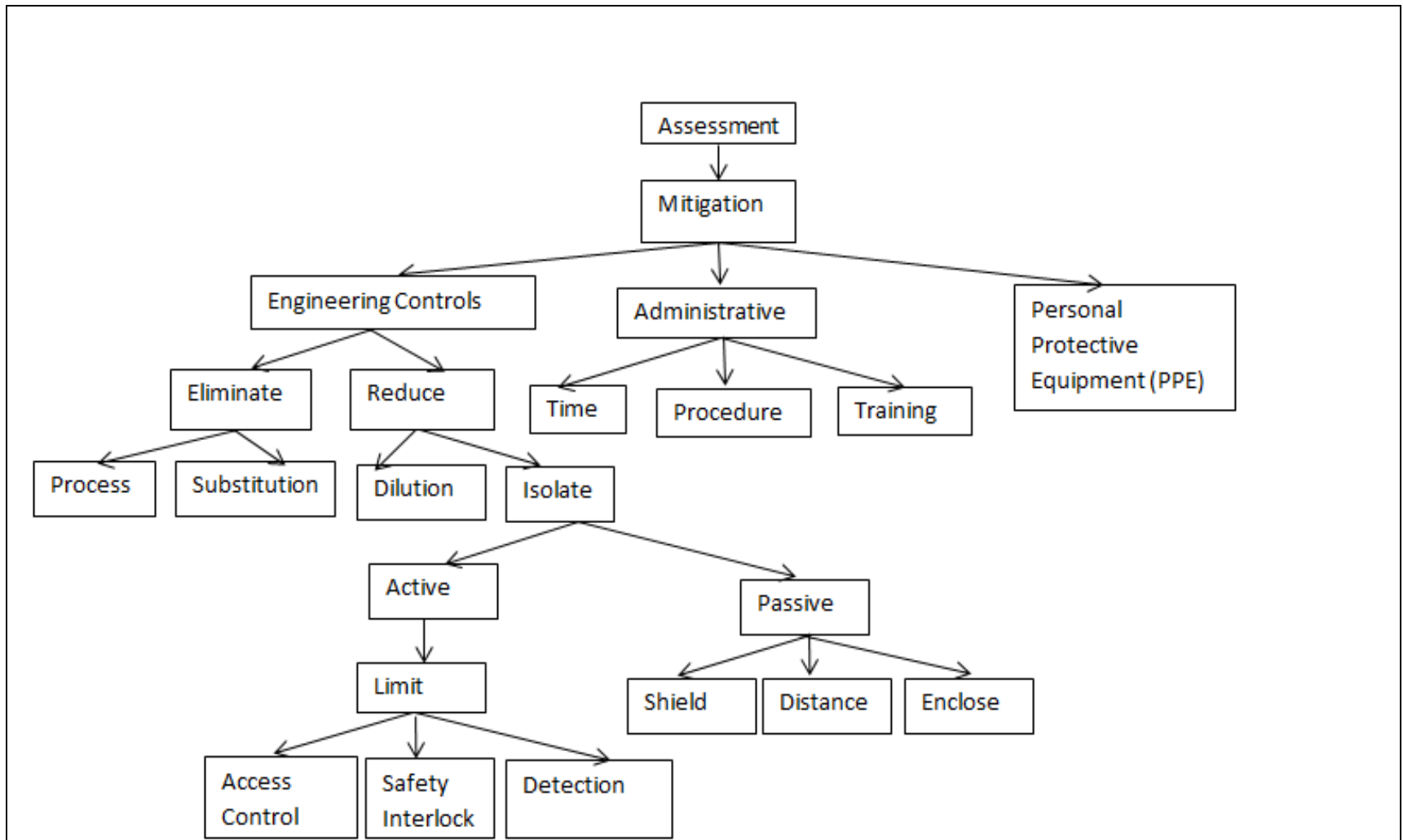
- Elimination/reduction of fall hazards
- Reduction of fall occurrence rates
- Reduction of fall injury/severity rates



This training will improve:

- Understanding of fall hazards
- Understanding of fall prevention strategies
- Knowledge, skills, and ability to avoid fall hazards and fall-related losses.

# Layer of Protection



# Fall Hazard Elimination/Reduction Strategies

- Eliminating the hazards through **engineering** design/practice
- Installing fall **protection systems**
- Providing **personal protective equipment**
- **Training personnel** for hazard recognition and avoidance

# Engineering Controls

- Follow all applicable laws/regulations (CFR 29, 1926: Safety and Health Regulations for Construction)
- Evaluate alternative equipment, alternative methods
- Conduct Job Safety Analysis(JSA)/design jobs to avoid hazards
- Evaluate maintenance, housekeeping needs, and develop policies, and procedures
- Develop written procedures (plans, protocols, checklists) for JSA, inspections, maintenance, communication, etc.
- Develop and implement training for each job/each equipment procedure

# Common Types of Fall Environments

- 1) Falls from ladders
- 2) Falls from scaffolding
- 3) Falls from or out of buildings
- 4) Other falls from one level to another (e.g., falls from stationary vehicles and falls from trees/walls)
- 5) Other and unspecified falls.

Examples of common elevated working environments.





# Ladder Safety

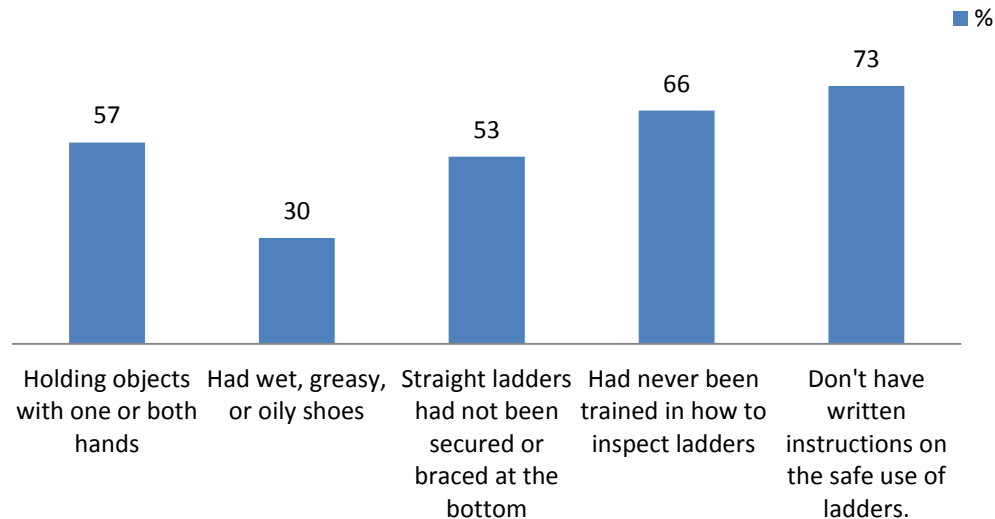
## Most Common Reasons of Ladder Accidents

- Wrong ladder used
- Ladder in poor condition
- Ladder used improperly / unbalanced

## Accident Statistic

According to Bureau of Labor Statistics study of 1,400 ladder accidents back up NIOSH's classification:

**Statistic of Accidents**



# Ladder Selection

## Ladder Selection

- A ladder must be the right **height** for the job so that you don't have to overreach.
- A ladder must have the **capacity** to support the weight that will be on it. Remember that the total weight a ladder has to support is your weight plus the weight of any tools and materials you use while working on the ladder.

## Weight rating system:

LOAD CAPACITY*	DESCRIPTION	CSA CODE	ANSI CODE
200 lbs./91 kg	Household - Light Duty	Grade 3	Type III
225 lbs./102 kg	Tradesman and Farm - Medium Duty	Grade 2	Type II
250 lbs./113 kg	Construction and Industrial - Heavy Duty	Grade 1	Type I
300 lbs./136 kg	Construction and Industrial - Heavy Duty	Grade 1	Type IA
375 lbs./170 kg	Construction and Industrial - Heavy Duty	Grade 1	Type IAA

\*Includes user and materials

# Ladder Selection

## No metal ladders around:

- **Electricity:** Check for metal parts and never use a ladder that is wet around electricity.
- **Corrosives:** Aluminum, steel, and acids are not compatible, so never use a metal ladder around corrosives and wet areas.
- **Flammables:** Do not use metal ladders around flammables the ladder could potentially cause a spark that could ignite around flammable parts.



# Ladder Inspection

All ladders should be inspected before each use.

Check to ensure that:

- Steps are in good condition/repair and free of mud, grease, oil or sticky substances
- Side rails have no cracks or splits
- Metal parts are lubricated
- Rope is not worn
- Spreaders or other locking devices are in place and working properly
- Splinters or sharp edges have been filed down
- Safety feet are solid and in place
- Metal ladders are free of dents, holes and bent parts
- You should also inspect ladders following any tip overs or possible damage to a ladder that has been struck by something, hit something, or been dropped

**Don't use and try to repair defective ladder!**

# Ladder Setup

- **4-to-1 rule:** Place the base of the ladder 1 foot from the wall for every 4 feet between the base and the support point. For instance, if it is 8 feet from the base of a ladder to its support point, the base of the ladder should be 2 feet away from the building.
- **Support point:** Extend extension ladders at least 3 feet above a support point such as the edge of a roof.
- **Overlap:** Ensure that the upper section of an extension ladder overlaps and rests on the bottom section. The overlap should always be on the climbing side of the ladder. For ladders of 36 feet or more, the overlap should be least 3 feet.
- **Secured:** Secure ladders at the top and bottom.

# Climbing-Descending

- **Never climb a ladder** if you are very tired, feeling ill, on medication that affects alertness or balance, or if you are impaired by alcohol or drugs.
- **Never slide down a ladder:** Descend safely, lowering one foot at a time and holding on to the side rails with both hands.
- **Carry tools on a belt or shoulder strap**
- **Don't climb higher** than the fourth rung from the top on a straight or extension ladder, or the second step from the top on a stepladder.
- **Face the ladder** when you go up or down, holding on to the side rails with both hands as you climb.
- **One person at a time:** Allow only one person on a ladder at a time.
- **Check your shoes:** Check your shoes before you climb, and wipe off wet, muddy, or greasy soles.

# Ladder Maintenance

Routine ladder maintenance should include:

1. Check joints
2. Test hardware and fittings
3. Lubricate moveable parts
4. Replace worn rope on extension ladders
5. Make sure safety feet are in good condition
6. Clean rungs and steps



# Scaffolds Safety

**Scaffolds:** A temporary elevated platform and its supporting structure used for supporting workmen, materials, or both in the construction or repair of buildings and other large structures.

## Type of Scaffolds:

1. **Suspended scaffolds** are platforms suspended by ropes, or other non-rigid means, from an overhead structure.
2. **Supported scaffolds** consist of one or more platforms supported by outrigger beams, brackets, poles, legs, uprights, posts, frames, or similar rigid support.
3. **Special use scaffolds** and assemblies are capable of supporting their own weight and at least 4 times the maximum intended load. The types of special use scaffolds include: Form and Carpenter Bracket, Roof Bracket, Outrigger, Pump Jack, Ladder Jack, Window Jack, Horse, Crawling Boards, Step, Platforms, and Trestle Ladder.

Falls in Construction/Fixed Scaffolds(2:58min) is available on [http://www.youtube.com/watch?v=-\\_HCde2jl34](http://www.youtube.com/watch?v=-_HCde2jl34)



# Scaffolds Hazards

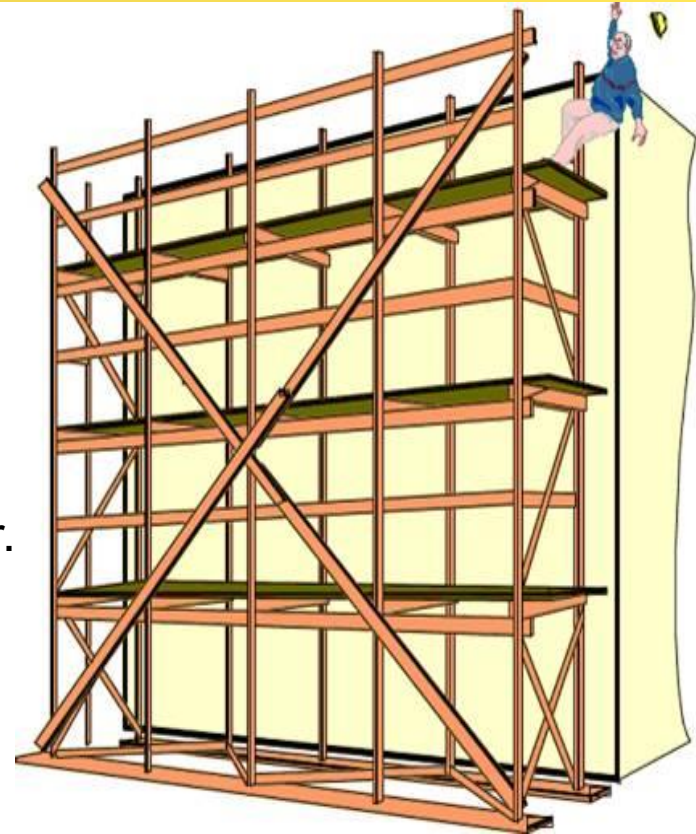
## Why Is Scaffold Safety Important?

Bureau of Labor Statistics studies showed that 25 percent of workers injured in scaffold accidents had received no scaffold safety training, and 77 percent of scaffolds were not equipped with guardrails.

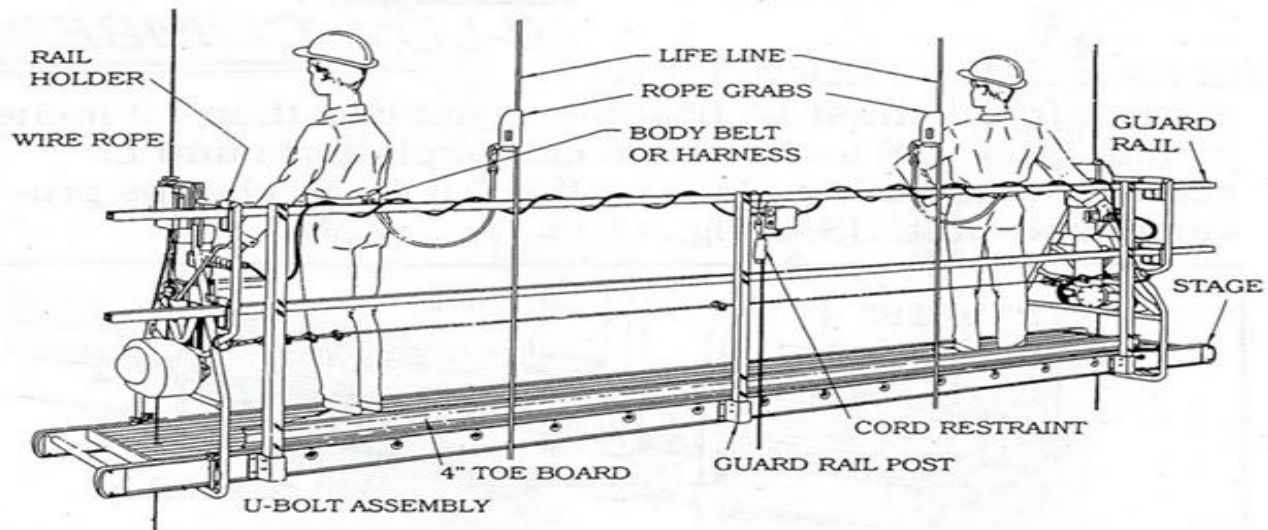
OSHA estimates that informed employers and workers, in compliance with correct safety standards, can save as many as 50 lives and prevent 4,500 accidents every year.

## Common Hazards Associated with All Scaffolds:

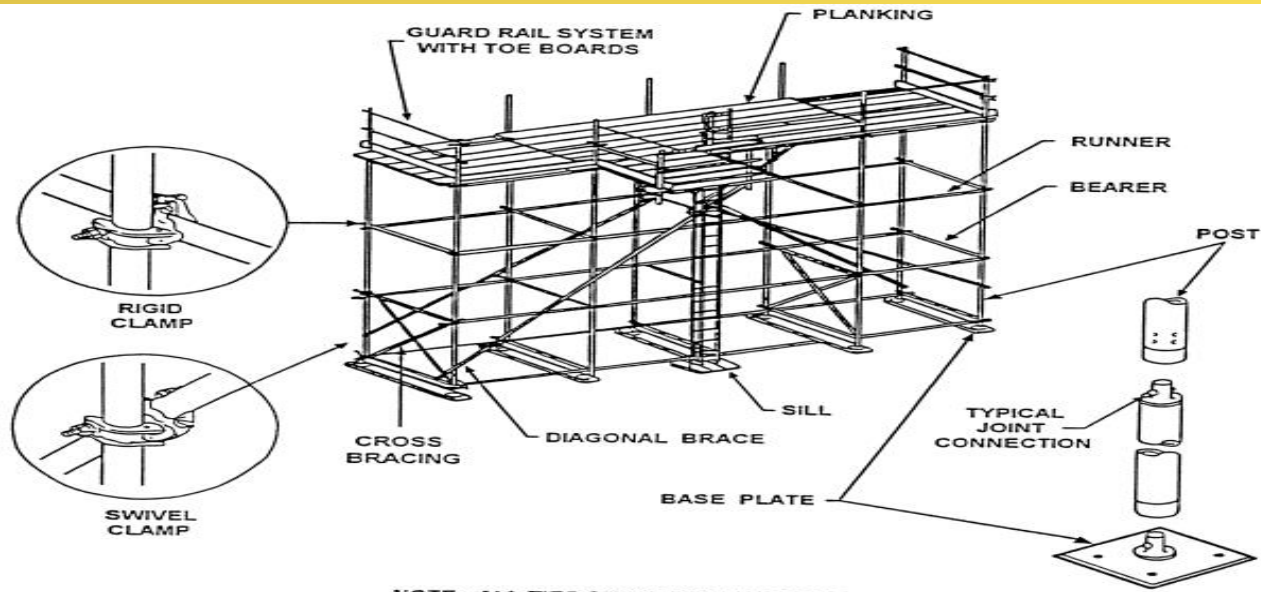
- Falls from elevation, due to lack of fall protection
- Collapse of the scaffold, caused by instability or overloading
- Being struck by falling tools, work materials, or debris
- Electrocution, principally due to proximity of the scaffold to overhead power lines.



# Suspended Scaffolds



# Supported Scaffolds

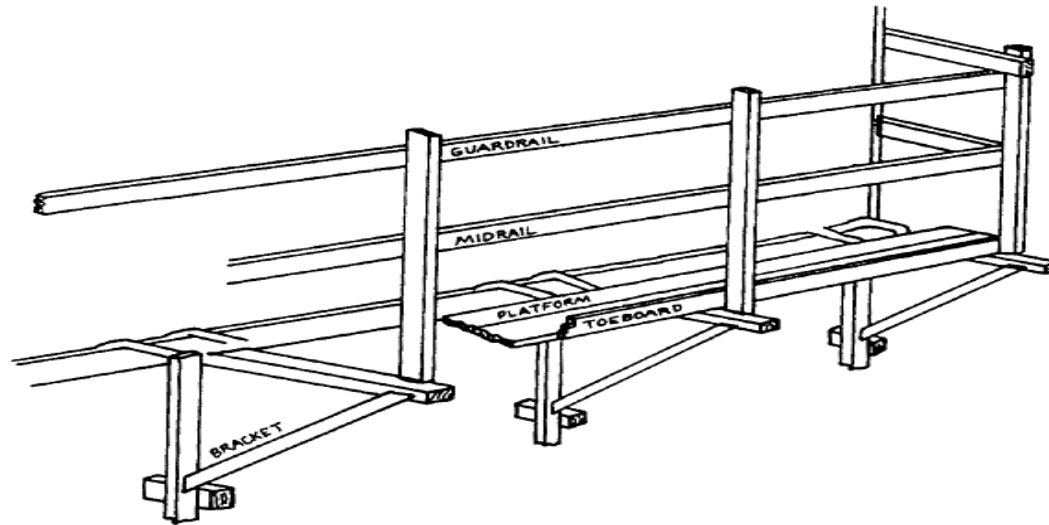


**NOTE: ALL TIES SHOULD BE LOCATED AT CLAMP LOCATIONS.**



# Special Use Scaffolds

## CARPENTER'S BRACKET SCAFFOLD



# Scaffolds Fall Protection

- Scaffolding 10' or higher must have some means of fall protection:
  - guardrails or
  - personal fall arrest system (PFAS)
- Toprails installed between 38" and 45" High.
- Midrails installed halfway between toprail and platform.
  - Cross bracing ok as guardrails if the center point is between **20" to 30"** for **Midrail** and **38" to 45"** for **Toprail**.
- Toprails to 200 lbs. of force/Midrails to 150 lbs. of force in any direction.

## Erecting and Dismantling:

- Fall protection should be used when feasible and when it does not create a greater hazard
- Competent person determines the feasibility and safety of providing fall protection.
- Anyone working on or around a scaffold must wear a hard hat.
- Workers on or below scaffolds must be protected from falling objects by:
  - Toeboards
  - Mesh
  - Screens
  - Equivalent measures

# Scaffold Capacity

- Scaffolds must be capable of supporting its own weight and at least 4x the expected load.
- Expected load includes:
  - Workers
  - Equipment
  - Tools
  - Materials

Scaffold Capacity = Expected Load x 4

400 lbs of Workers

100 lbs of Tools

+ 100 lbs of Materials

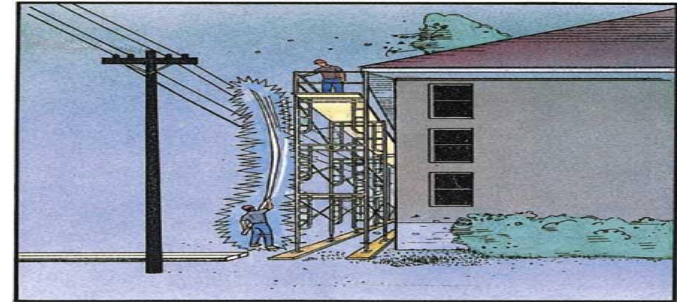
600 lbs x 4 = 2,400 lbs

# Safety Requirements for Scaffolds

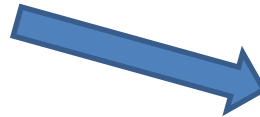
- All load-carrying timber members of scaffold framing shall be a minimum of 1,500 fiber construction grade lumber.
- All planking must be Scaffold Grades. The maximum permissible span for 2 X 9 inch or wider plank full thickness shall be 4 feet with medium duty loading of 50 p.s.i.
- All planking or platforms must be overlapped (minimum 12 inches) or secured from movement.
- An access ladder or equivalent safe access must be provided.
- Scaffold plank must extend over their end supports not less than 6 inches or more than 18 inches.
- Slippery conditions on scaffolds shall be eliminated immediately after they occur.
- Only treated or protected fiber or synthetic ropes shall be used for or near any work involving the use of corrosive substances or chemicals.
- Wire, synthetic, or fiber rope used for scaffold suspension shall be capable of supporting at least 6 times the intended load.

# Safety Requirements for Scaffolds

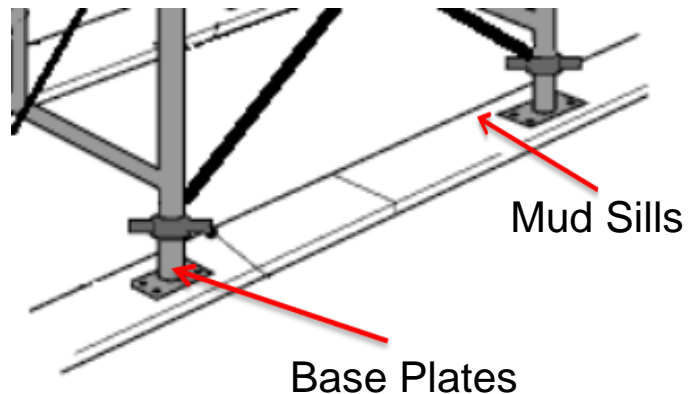
A safe distance from energized power lines shall be maintained (i.e., minimum distance of 3' for insulated lines less than 300 volts; 10' for insulated lines 300 volts or more).



Scaffolds shall not be used during high wind and storms. Storm Collapses Scaffolding in Denmark.



Unstable objects shall not be used to support scaffolds or platform units.



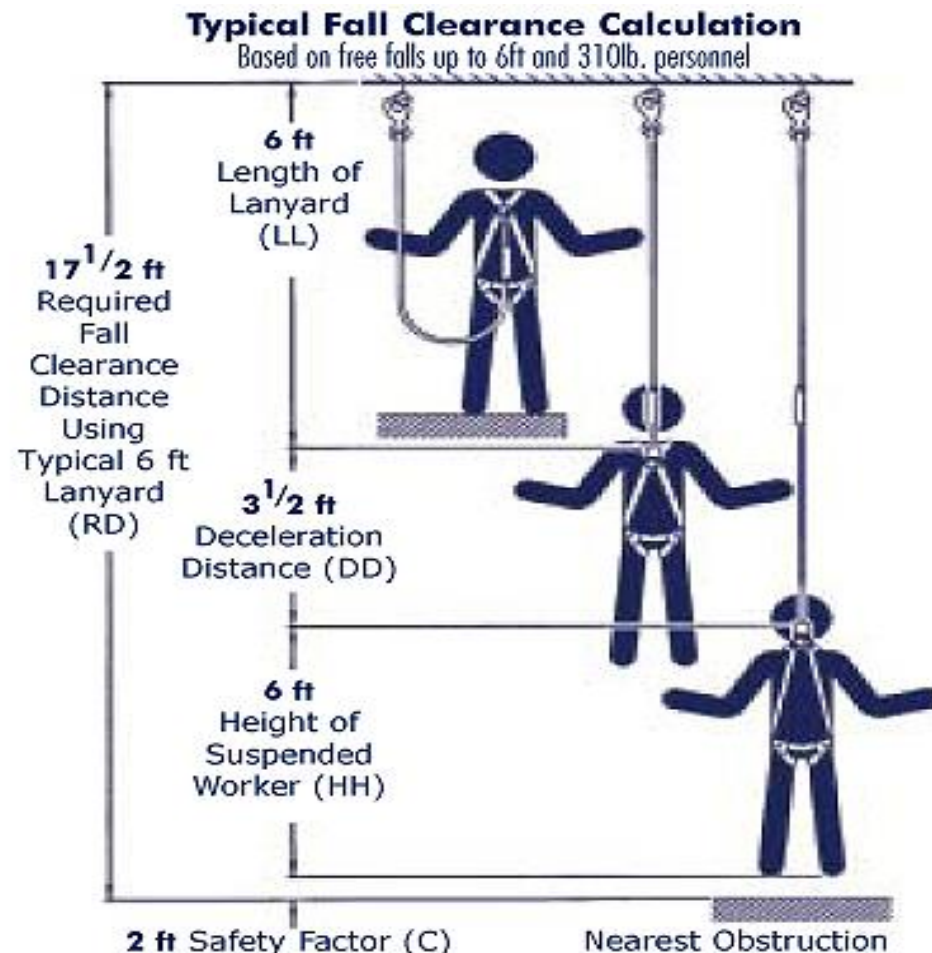
The poles, legs, or uprights of scaffolds must be plumb and rigidly braced to prevent swaying.



# Safety Requirements for Scaffolds

- Scaffolds shall be provided with a screen between the toe board and guardrail, when personnel are required to work or pass underneath the scaffolds.
- Tag lines shall be used to hoist materials to prevent contact.
- Suspension ropes shall be protected from contact with heat sources and corrosive substances.
- Ladders and other devices shall not be used to increase working heights on scaffold platforms.
- Scaffolds shall not be moved while employees are on them.
- Loose materials, debris, and/or tools shall not be accumulated to cause a hazard.
- Employees working on suspended scaffolds shall employ a fall-arrest system.
- Scaffolds shall be inspected before each work shift.
- Casters and wheels must be positively locked if in a stationary position.
- Tube and coupler scaffolds shall be tied to and securely braced against the building at intervals not to exceed 30 feet horizontally and 26 feet vertically.

# Calculating Fall Clearance



LL = Lanyard Length  
 DD = Energy Absorber Deceleration Distance (3.5 Ft Total)  
 HH = Height of the Harness Dorsal D-Ring from the Worker's Feet  
 C = Clearance to Obstruction During

Fall Arrest (1 Ft Required Plus 1 Ft for D-Ring Movement and System Materials Stretch = 2 Ft Total)  
 RD = Required Distance Below Anchor Point to Nearest Obstruction  
 $RD = LL + DD + HH + C$

# Common Fall Protection Ways

- Guardrail systems
- Safety net
- Personal fall arrest
- Warning line system
- Controlled access zone

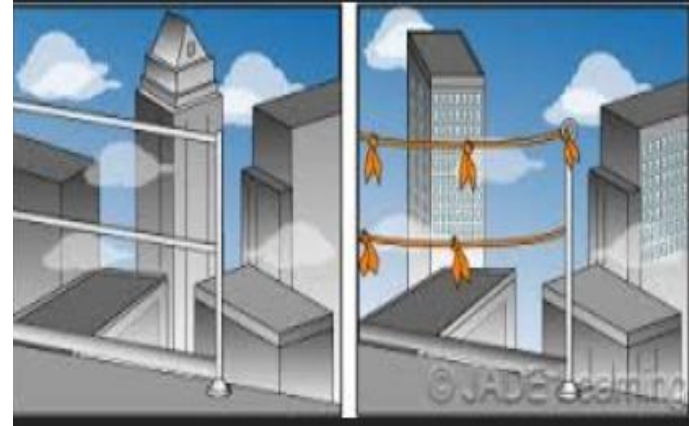
# Guardrail Systems

- Toprails and midrails of guardrail systems must be at least one-quarter inch thick to prevent cuts and lacerations.
- If wire rope is used for toprails, it must be flagged less than 6 feet intervals with high-visibility material.
- All guardrail systems must be constructed with a top rail and a mid rail.
- The top rail must support 200 lbs. of force downward and outward. The mid rail must support 150 lbs of force.



# Guardrail Systems

- Steel and plastic banding cannot be used as toprails or midrails. Manila, plastic, or synthetic rope used for toprails or midrails must be inspected as frequently as necessary to ensure strength and stability.
- The top edge height of toprails, or guardrails must be 42 inches plus or minus 3 inches, above the walking/ working level.



# Safety Net

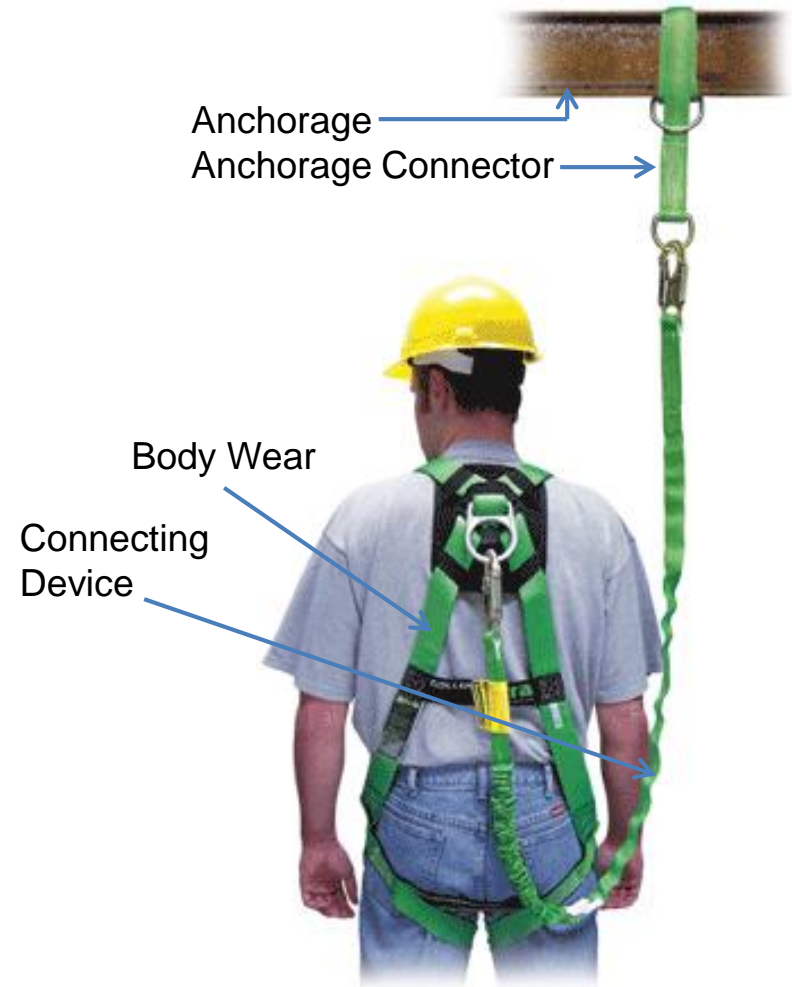
- Safety nets must be installed as close as practicable under the walking/working surface on which employees are working and never more than 30 feet below such levels.
- Safety nets shall be inspected at least once a week for wear, damage, and other deterioration.
- The maximum size of each safety net mesh opening shall not exceed 36 square inches nor be longer than 6 inches.
- Each safety net or section shall have a border rope for webbing with a minimum breaking strength of 5,000 pounds.
- Safety nets must extend outward from the outermost projection of the work surface as follows:

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



# Personal Fall Arrested Systems(PFAS)

- Dee-rings & snap hooks
- Horizontal lifelines
- Lanyard or lifeline
- Anchorage point
- Connecting devices
- Hard hat
- Body belt
- Body harness



# Personal Fall Arrested Systems(PFAS)

A Personal Fall Arrest System is comprised of three (3) key components – anchorage connector; body wear; and connecting device. The connecting device between anchorage connectors and body wear bears the greatest fall forces during a fall.

- **Anchorage:** Commonly referred to as a tie-off point (Ex: I-beam, rebar, scaffolding, lifeline, etc.)
- **Anchorage Connector:** Used to join the connecting device to the anchorage (Ex: cross-arm strap, beam anchor, D-bolt, hook anchor, etc.)
  - Anchorages must be capable of supporting 5,000 pounds of force per worker.
  - Must be high enough for a worker to avoid contact with a lower level should a fall occur.
  - The anchorage connector should be positioned to avoid a “swing fall.”



I-Beam Adjustable  
Strap



Roof Tie-Off



Permanent Roof-top



# Personal Fall Arrested Systems(PFAS)

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



# Personal Protective Equipment (PPE)

- **Connecting Device:** The critical link which joins the body wear to the anchorage/anchorage connector (Ex: shock-absorbing lanyard, fall limiter, self-retracting lifeline, rope grab, etc.)
  - Potential fall distance must be calculated to determine type of connecting device to be used – typically, under 18-1/2 ft., always use a self-retracting lifeline/fall limiter; over 18-1/2 ft., use a shock-absorbing lanyard or self-retracting lifeline/fall limiter.
  - Should also be selected based on work to be performed and the work environment.
  - Shock-absorbing lanyards can expand up to 3-1/2 ft. when arresting a fall; attach lanyards to the harness back D-ring only; never tie a knot in any web lanyard – it reduces the strength by 50%.



Lanyards



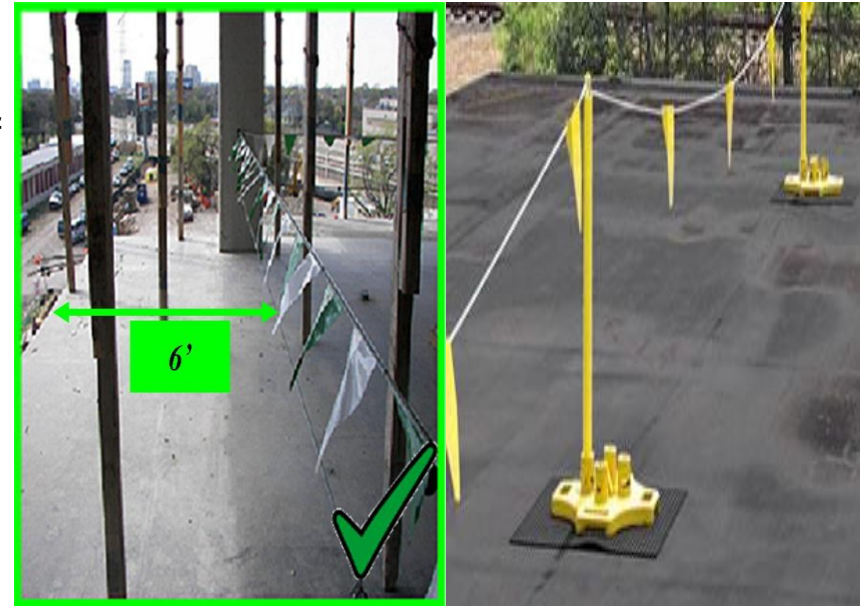
Retractable lifelines



Shock absorbing lifelines

# Warning Line Systems

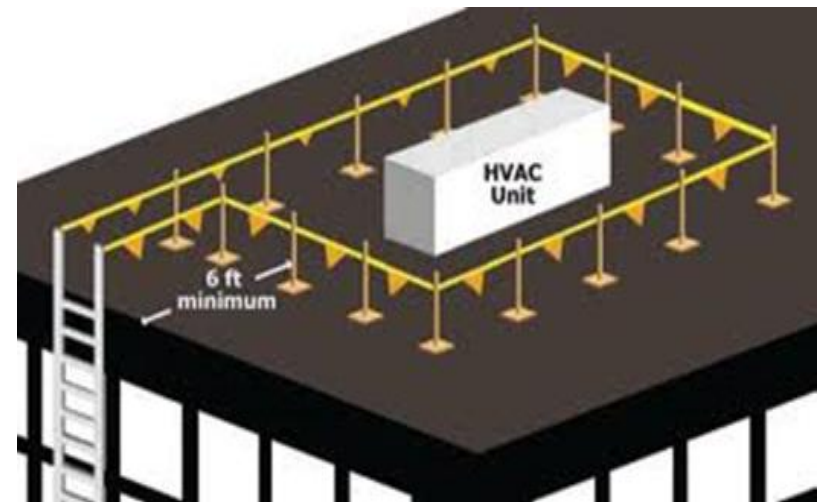
- Warning line systems consist of ropes, wires, or chains, and supporting stanchions.
- Flagged at not more than 6-foot intervals with high-visibility material.
- Rigged and supported so that the lowest point is no less than 34 inches from the walking/working surface and its highest point is no more than 39 inches from the walking/working surface.
- Stanchions, after being rigged with warning lines, shall be capable of resisting, without tipping over, a force of at least 16 pounds applied horizontally against the stanchion, 30 inches above the walking/working surface, perpendicular to the warning line and in the direction of the floor, roof, or platform edge.
- The rope, wire, or chain shall have a minimum tensile strength of 500 pounds.
- When mechanical equipment is being used, the warning line shall be erected not less than 6 feet from the roof edge parallel to the direction of equipment operation, and not less than 10 feet from the roof edge perpendicular to the direction of mechanical equipment operation.



# Controlled Access Zones(CAZ)

A Controlled access zone (CAZ) is a work area designated in which certain types of work (such as overhand bricklaying) may take place without the use of conventional fall protection systems(e.g. guardrail, personal arrest or safety net)

- Controlled access zones, when created to limit entrance to areas where leading edge work and other operations are taking place, must be defined by a control line. Control lines shall consist of ropes, wires, tapes and supporting stanchions, and each must be:
- Flagged or otherwise clearly marked at not more than 6-foot intervals with high-visibility material.
- Rigged and supported in such a way that the lowest point is not less than 39 inches from the walking/working surface and the highest point is not more than 50 inches when overhand bricklaying operations are being performed.
- Strong enough to sustain stress of not less than 200 pounds.
- Control lines also must be connected on each side to a guardrail system or wall.
- When control lines are used, they shall be erected not less than 6 feet nor more than 25 feet from the unprotected or leading edge.
- Controlled access zones when used to determine access to areas where **overhand bricklaying** and **related work** are taking place are to be defined by a control line erected not less than 10 feet nor more than 15 feet from the working edge.



# References

- <https://www.osha.gov/doc/outreachtraining/htmlfiles/subpartm.html> “Construction Safety and Health Outreach Program” U.S. Department of Labor OSHA Office of Training and Education, May 1996
- Mark C. Radomsky, Joseph P. Flick, Garold Russell & Raja V. Ramani “ Fall Prevention Training Program” The Pennsylvania State University, University Park, PA [http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCwQFjAB&url=http%3A%2F%2Fwww.usmra.com%2Frepository%2Fcategory%2Ffall\\_protection%2FFall\\_Prevention\\_Training.ppt&ei=mtc6U4CEEqjKsAS844GICw&usg=AFQjCNFAtDWY7LlOwtI3wCILFywxighzv](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCwQFjAB&url=http%3A%2F%2Fwww.usmra.com%2Frepository%2Fcategory%2Ffall_protection%2FFall_Prevention_Training.ppt&ei=mtc6U4CEEqjKsAS844GICw&usg=AFQjCNFAtDWY7LlOwtI3wCILFywxighzv)
- Miller by Honeywell, 2014. “Personal Fall Arrest System” (Available Online 4/1/2014) <https://www.millerfallprotection.com/smart-solutions/guide-to-fall-protection/personal-fall-arrest-system>
- Susan Miller “ABC’s of Fall Protection” Murray State University.
- USPAS January 2012 “Controlling Risks Hazard Reduction” [http://uspas.fnal.gov/materials/12UTA/10\\_hazard\\_reduction.pdf](http://uspas.fnal.gov/materials/12UTA/10_hazard_reduction.pdf)
- “Fall Clearance Calculation” (Available Online 4/3/2014) [http://fallprotectionusa.com/DBI/Srls/fall\\_clearance\\_chart.html](http://fallprotectionusa.com/DBI/Srls/fall_clearance_chart.html)
- “Ladder Safety Training” (Available Online 4/4/2014) [www.co.nueces.tx.us/risk/training/Ladder%20Safety.ppt](http://www.co.nueces.tx.us/risk/training/Ladder%20Safety.ppt)
- Parbhu, V.N., 2012. “Scaffolding Training” EERC Theramx Ltd. <http://www.slideshare.net/jag89singh/scaffolding-14601421>
- <https://www.osha.gov/SLTC/etools/scaffolding/overview/index.html> “Overview” U.S. Department of Labor. (Available Online 4/8/2014)
- Frankenmuth Insurance, 2014. [http://www.fmins.com/pdf/safety\\_SERVICES/Scaffold.pdf](http://www.fmins.com/pdf/safety_SERVICES/Scaffold.pdf) “Scaffold Safety Program” (Available Online 4/8/2014)
- National Association of Home Builders. “Scaffold and Ladder Safety Training”
- [http://erd.dli.mt.gov/component/docman/cat\\_view/9-safety-health/10-safety-health-publications.html?Itemid=297](http://erd.dli.mt.gov/component/docman/cat_view/9-safety-health/10-safety-health-publications.html?Itemid=297) Montana Department of Labor & Industry Employment Relations Divisions (Available online 4/11/14)
- <http://www.jade1.com/jadecc/accounts/loginnew.php>
- United States Department of Labor Occupational Safety and Health Administration. “Big Four Construction Hazards: Fall Hazards” (Available Online 4/16/14)
- <http://www.whalenjack.com/installation/scaffold/>
- <https://www.osha.gov/dte/library/scaffolds/scaffolding/handout.html>
- <http://canada.wernerco.com/support/ladder-safety-tips/how-to-choose-a-ladder>
- <http://dailypicksandflicks.com/2013/10/28/storm-collapses-scaffolding-in-denmark-video/>
- University of Alabama, Collage of Continuing Studies. “Fall Protection – Taking it to a Whole New Level” ” (Available Online 4/17/2014) [https://www.osha.gov/dte/grant\\_materials/fy10/sh-21006-10.html](https://www.osha.gov/dte/grant_materials/fy10/sh-21006-10.html)



WICHITA STATE  
UNIVERSITY

**Thank you!**

**Be Safe**

**Wichita State University  
Department of EH&S**