

Fall Protection

Overcoming Misconceptions in Residential Construction

By Jeremy Bethancourt

Over the past 5 years as the economy continues to improve, a growing number of workers are returning to jobs in construction. Historically, an increase in employment means that more workers are exposed to hazards that will likely result in more serious and fatal injuries (Asfaw, Pana-Cryan & Rosa, 2011; Boone & Van Ours, 2006; Davies, Jones & Nunez, 2009). Among the top four reasons construction workers are injured, falls remain the leading cause of fatal injury (BLS, 2016; Dong, Largay & Wang, 2014).

To improve safety in the residential and light commercial construction sectors, in 2008 the industry requested that OSHA cancel a temporary fall protection variance. It was said that the guidelines caused confusion among employers as to what fall protection should be provided to workers (Howard, 2008).

OSHA followed that request and fall protection awareness in the residential and light commercial construction industry has been slowly improving over the past 5 years. However, with workers continuing to be seriously injured and killed, clearly more can be done to ensure that workers are protected. In evaluating BLS data, it seems that despite efforts to educate the workforce and employers, many workers are still not being provided proper fall protection or adequate fall protection training (EHSO, 2014; Epstein, Becker & Green, 2013; NSC, 2010; OSHA, 2016; Siddiqui, 2014).

According to OSHA, all construction workers exposed to fall hazards more than 6 ft must be provided fall protection in the form of a guardrail, safety net or personal fall arrest system. OSHA (2010) has also stated that personal fall restraint, when applied correctly, is acceptable to use. For the purposes of this article, fall protection will be understood as the backup system(s) planned for a worker who could lose his/her balance at height to control or eliminate injury potential. Accordingly, it is any active means to provide protections to workers who experience gravitational forces that could cause them to hit a lower level or object. This article does not evaluate the use of guardrail systems or safety net systems, which could be considered more passive systems. However, it should be noted that the methodologies discussed are equally applicable to those systems.

So, why are personal fall arrest systems not yet employed universally to eliminate construction fall fatalities? Some reasons include a confirmatory bias that fall protection systems are not required, a claim that exposing workers to fall hazards for up to 30 minutes is somehow reasonable and a misunderstanding of OSHA's requirements (Cable, 2006; J. Pace, personal communication, 2008; Stromme, 2011). Additionally, some have argued that providing workers with fall protection systems would be financially burdensome to the industry (Johnson, 2011; C. Wilhelm, personal communication, 2012).

Furthermore, most training and guidance seems to simply restate well-known OSHA standards with no real solutions as to how industry can translate those standards into protection for workers. *Residential construction industry* (which includes new building and roofing, remodeling and reroofing) is defined as using wood frame construction materials and methods characterized with exteriors and interiors made of wood (or equivalent cold-formed sheet metal stud) framing, not steel or concrete, wooden floor joists and roof structures all using traditional wood frame construction techniques (OSHA, 2010). *Light commercial construction* is defined as the building of nonresidential structures

IN BRIEF

- Many in the residential and light commercial construction industry consider fall protection infeasible, impractical and overly burdensome to industry.
- By experimenting with equipment and procedures that meet ANSI and OSHA standards, it has been demonstrated that fall protection is feasible even where roof heights are as low as 8 ft.
- With this information, manufacturers, regulators and academia can provide additional guidance to the residential and light commercial construction industry on how to provide fall protection.
- This article offers guidance to help employers identify fall protection strategies that will increase worker sustainability and reduce injury burdens.

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where the environment, methods, materials and procedures used are similar to those used to build single-family residences (ACCSH, personal communication, Dec. 2009; OSHA, 2010).

For a safer workplace, industry and OSH professionals must embrace an approach that has been demonstrated to be effective; with broad implementation, the industry can reduce and eventually eliminate falls from heights. Industry must methodically deploy fall protection systems that allow management and workers not only to understand the applications but also to encourage developing solutions within the flexible methodology for using fall protection.

Redefining Understanding

Some employer advocates say that OSHA limits employers by mandating only three types of fall protection systems. To make improvements, industry must not see fall protection requirements as restrictive, but rather as an opportunity to ensure that workers are truly protected.

For example, suppose OSHA says that the employer shall use one of the following three modes of transportation to get to work: motor vehicles, human-powered transport or public transportation. Within those three modes are literally thousands of different types, manufacturers and styles of transportation. Among the hundreds of different options are cars, trucks, motorcycles, bicycles, scooters, skateboards, roller skates, boats, trains, taxis, buses and airplanes.

Industry should look at fall protection systems the same way. There are literally thousands of compatible combinations available within the three modes of fall protection systems that OSHA defines. OSH professionals must evaluate each possible scenario and research systems to find a combination(s) that protects workers in accordance with OSHA's direction.

Understanding what is available is not the only obstacle. To successfully improve fall protection for workers, OSH professionals and industry must either eliminate the possibility of workers falling off

structures via engineering controls (e.g., permanent parapet walls around the entire roof structure) or change outdated paradigms. Some prevalent misconceptions include unacceptable financial cost, perceived additional structural requirements and a fundamental misunderstanding of OSHA fall protection standards.

Those paradigms were a cornerstone in allowing the temporary fall protection variance OSHA Instruction STD 03-00-001 (formerly STD 3.1 renumbered STD 3.1A) to continue beyond any reasonable purpose. Those misconceptions are largely responsible for a lack of worker safety improvements in the residential/light commercial construction industry that contribute to serious injuries and deaths.

So long as single- and multifamily homes and commercial structures continue to be built with wood and light-gauge cold-form steel, industry and OSH professionals must acknowledge and accept that alternate fall protection plans (as dictated by OSHA and lobbied for by certain portions of the industry) are not a commensurate means of keeping workers from harm when they are subjected to the effects of gravity.

Alternate fall protection plans are onerously prescriptive and cannot take into account human error or the fast-changing pace of most construction sites. Experience over the past 2 decades shows that fall protection plans are often a failed exercise to control recurring hazards with a behavior-based approach. Alternate fall protection plans are passive administrative controls and are not fall protection by any reasonable definition. If anything, alternate fall protection plans are an attempt to avoid the effects of gravity by telling workers to be careful.

Understanding the Paradigms *Structural Infeasibility*

It is a long-held misconception that fall protection in residential and light commercial construction is infeasible or a greater hazard to workers. The greater hazard argument would have to be based on something worse than falling to one's

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death. The myth regarding infeasibility is based partially on the first part of 29 CFR 1926 502(d)(15), which states that an anchor must support at least 5,000 lb to be compliant.

Those who make such assertions argue that since wood frame structures are not specifically designed for fall protection, they would not be able to support the forces of a worker's arrested fall. In support of that position are letters and literature from industry stating that a single roof truss (rafter) is not designed to withstand such loads (K. Grundahl, personal communication, 2008; NAHB, 2012).

Using that position as a basis to establish infeasibility is misleading. A single truss (or rafter) is never intended to 1) stand on its own and 2) hold up an entire roof. The truss/rafter is part of the entire roof structure and the system can act as an anchor point with adequate temporary bracing and/or adequate sheathing. By attaching an anchor to a roof system that is adequately braced and/or appropriately sheathed, rather than a single truss, the second part to the regulation is attainable (ACCSH, personal communication, 2007; C. Baker, personal communication, 1995; Dimakis, 2011).

That second part of 29 CFR 1926 502(d)(15) states:

Anchorage used for attachment of personal fall arrest equipment . . . shall be designed, installed and used as part of a complete personal fall arrest system which maintains a safety factor of at least two; and under the supervision of a qualified person. (OSHA, 2014)

To fully embrace the methodology allowed under the second part of 29 CFR 1926.502 9(d)(15) requires noting published misinformation. First, the two-times safety factor is not applied to the 5,000-lb load. Simply doubling the 1,800-lb maximum allowable arresting force permitted by OSHA is also not prudent because it fails to acknowledge where manufacturers of personal fall arrest system components have already created a system that limits arresting forces to between 500 and 900 lb.

Finally, it is not required by OSHA to solicit the services of a registered engineer to have that engineer validate and certify the fall protection system. The only requirement of the two-to-one safety factor is to know what the anticipated load on the system will be. Guessing without knowing the capabilities of the systems being employed is not an option, nor is it professional. Load information is readily attainable from manufacturers, by doing research or through individual assessment of components and systems.

The OSH professional should remember that protocols for evaluating fall protection systems are available through ANSI and from OSHA by way of the guidelines in CFR 1926 Subpart M, Appendix C. By following the evaluation protocols in Appendix C of Subpart M, an anticipated load of 700 to 900 lb has been validated through published testing (ACCSH, personal communication, 2007; Bethancourt & Cannon, 2016; Dimakis 2011). Those loads are achieved because engineers, safety professionals and qualified persons have taken a front-end approach by designing fall protection

equipment that limits arresting forces on a worker to less than half the 1,800 lb permitted by the standard, well below 5,000 lb.

Thus, the criteria for structural designs to support the 5,000-lb requirement for an uncertified anchor point are not applicable where workers use appropriate fall protection systems designed by a qualified person. As defined by OSHA (2014), a qualified person is:

One who, by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience has successfully demonstrated his/her ability to solve or resolve problems relating to the subject matter, the work or the project.

Cost Infeasibility

Another misconception within the residential construction industry is that fall protection for workers adds unacceptable costs to the job. Some estimate that providing fall protection could cost \$5,000 or more per structure (C. Wilhelm, personal communication, 2012). The author's research and real-world experience cannot reconcile this figure. Because continually enlisting the services of a certified engineer is not required, the average cost of providing fall protection can be between \$200 and \$500 for a single-family house (Bethancourt & Cannon, 2015; NIOSH, 2015). That amount is far from infeasible considering the cost of an average new-build home ranges from \$250,000 to \$450,000 (Taylor, 2015).

Clearance Infeasibility

The concern about clearance infeasibility is based on equipment manufacturer guidance that led to a belief that not enough ground clearance exists on typical single-family structures for workers to use fall arrest systems (Biggs & Griffin, 2014; NAHB, 2012). When OSH professionals understand the limits of the different components available when putting together a system, ample clearance distance exists on the average single-level family structure with 8-ft wall heights (Bethancourt & Cannon, 2016).

Since ACCSH first recommended to OSHA that the interim fall protection guidelines should be rescinded, many manufacturers have created guidance to use specific equipment on leading edges. According to OSHA (2014), a leading edge is "the edge of a floor, roof or formwork for a floor or other walking/working surface (such as the deck) which changes location as additional floor, roof, decking or formwork sections are placed, formed or constructed." Where the minimum wall height of a typical residential structure is never less than 8 ft, several applications and systems are available that would arrest a falling worker before s/he hit the ground (Bethancourt & Cannon, 2015; 2016).

The Methodology

At first, creating a methodology to describe how the residential and light commercial construction industry can implement fall protection may seem



(Clockwise from top left) Photo 1: Workers protected from internal swing fall hazards, within the 30° arch due to minor additional bracing, and outside 30° where the force of gravity is cancelled due to the friction of the cable against the incline of the trusses.



Photo 2: Workers protected from swing fall using personal fall arrest systems while installing sheathing on a braced and partially sheathed roof.



Photo 3: Worker protected from swing fall on fully sheathed roof via strategic positioning of an anchor point.

simple. However, for years the author has observed individuals who do not understand why the systems work try to imitate lessons learned, demonstrating that it is not so simple.

As originally conceived, fall protection plans are intended as a last resort after an employer has evaluated a situation and determined that it is infeasible (impossible) to provide traditional fall protection systems for workers, or that it is more hazardous to use fall protection systems (OSHA, 2014). As they prepare to implement a fall protection program, employers should remember several key points:

1) Employers must stop being resistant to seeking advice and counsel from peers and experts who have achieved success. Employers must be willing to embrace a better way when past efforts have not been as effective as anticipated. Employers should embrace OSHA consultation and the intent of the OSHA Fall Prevention Campaign.

2) So long as the employer provides fall protection and proper training, the employer has the power and moral responsibility to decide how to protect workers, not OSHA. OSHA's role is to compel employers to do something more than telling workers to be careful.

3) Industry associations may not be the best source of information when it comes to choosing a correct course of action. While advocacy groups are great at lobbying techniques and ways to promote a business, their general understanding of safety may make it difficult to direct specific applications.

4) Focusing on the intent of the regulation is more important than focusing on exploiting legal technicalities that might provide short-term financial gain or enable an employer to avoid its obligations to keep workers safe.

5) Do not focus on short-term setbacks as the program begins. Workers and management will experience

a learning curve. Given time, the benefits of a proactive approach will outweigh initial resource allocations.

System Use

Although fall protection systems and equipment have been available and used in industry for decades until about 15 years ago, use of those systems was not widely promoted in residential/light commercial construction. Manufacturers produce guidance based on an existing or anticipated demand. That does not mean the products could not be used in other applications; rather it likely never occurred to manufacturers to learn whether such use was feasible because at the time of development there may not have been a demand for use in residential/light commercial construction. Judging by the lack of systems that addressed the residential construction industry before June 2006, manufacturers did not anticipate that residential/light commercial contractors would purchase fall protection systems for workers, thus there was little guidance for use of these systems in this sector.

When demand increased, manufacturers began investigating more ways to provide guidance and information on how their equipment could be adapted for use by residential/light commercial employers. However, because initial guidance did not seem to be created in collaboration with users, guidance was still limited to generally applicable photographs of workers wearing equipment at heights, repeating statutory requirements and stating legal disclaimers as to use.

It was not until manufacturers collaborated with pioneering end-users that guidance began to be promoted by researchers and the regulated community. Manufacturers began to understand that industry was attempting to apply their products in a different environment. Consequently, more interaction occurred during the development pro-

Photo 4 (top): Mike Pentecost demonstrates the proper way for workers to use a traditional rope lanyard with a Prusik knot. A potential swing fall is reduced where he demonstrates the importance of adjusting the rope grab.



Photo 5 (bottom): This worker using an SRL on a fully sheathed roof is protected from a swing fall by limiting the distance he moves away from the anchor point.



not provide adequate protection. Simply reading the equipment instruction manual is not enough. Employers and workers must understand how the different systems will react in any given situation to decide whether different equipment and/or processes must be employed.

As an example, let's discuss the traditional understanding of swing fall hazards. Most literature and guidance documents include a discussion of ensuring that a worker's use of a lanyard attached to an anchor point should not exceed more than 30°. While that guidance might work well for some industries and occupations such as steel workers, rolling stock loaders, grain handlers or shipyard workers, it does not apply equally in wood frame construction where roof structural members may be partially or fully braced but not fully sheathed (Photos 1, 2 and 3, p. 61).

As illustrated, there is a difference in application of the systems depending on whether the roof/floor system is open (i.e., adequately braced but not sheathed, Photo 1) or closed (i.e., fully sheathed and braced, Photo 3). On an open system, workers must ensure that they avoid an internal swing fall whenever within 30° and have limited potential for swing fall outside 30° due to the slope of the trusses. On a closed system, workers would need to ensure no more than 30°. Where there is a combination of braced and partially sheathed roof areas, which is often the case (Photo 2), workers must continually be aware of their surroundings to maintain the efficacy of the personal fall arrest systems they are using.

Similarly, where a standard rope lanyard would likely have numerous restrictions on an open roof or floor system due to inside swing fall potential, on a closed roof/floor system (Photos 4 and 5), rope lanyard might be the perfect application where the swing fall potential is kept under 30° from the worker to anchor attachment point on a horizontal plane near the leading edge.

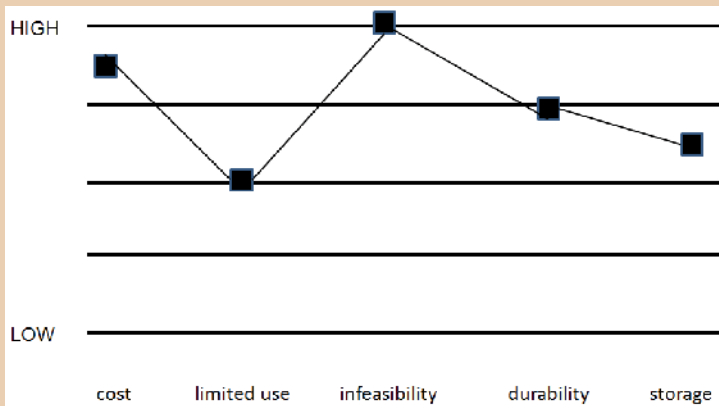
The methodology for implementing fall protection systems must be based on the use of the combination of equipment in any given situation rather than deciding infeasibility based on the inability to apply one particular component over another (Bethancourt & Cannon, 2016). Employers should make the fall protection fit the workplace, not try to fit the workplace to the system.

Management-Owner-Supervisor Commitment

As an organization embarks on the journey to safety excellence, management, from the top down, must be committed to the task even when the path proves difficult. Fall protection in residential construction is unfortunately associated with long-standing paradigms that leaders must resist and overcome. For safety leadership to be successful, it must ensure that management is in alignment with the safety goals (NIOSH, 2015). Without alignment or leadership buy-in, initiatives will fail.

Companies that are resistant to implementing fall protection create a value curve that emphasizes the characteristics shown in Figure 1 and focus only on the

FIGURE 1
Fall Protection Value Curve Posited by Resistant Residential Construction Employers



cess, which in turn created better understanding of applicability of existing products and, thereby, enabled even more written guidance.

Today, numerous resources and guidance documents are available from OSHA, NIOSH, CPWR—Center for Construction Research and Training, industry associations and manufacturers that employers can use to determine systems applicable for various trades. Researchers have worked to provide online tools to show contractors and users which products can be used to provide fall protection at different stages of construction.

Prior to implementing a fall protection program, employers and OSH professionals must understand the dynamics of why and how certain fall protection components work. Users must understand the limits of the systems so they can adapt their use in situations where the systems might

FIGURE 2

Eliminate-Reduce-Raise-Create Grid to Redefine Fall Protection

Eliminate	Raise
Guardrails Nets Infeasibility	Ease of use Versatility
Reduce	Create
Cost	Cost savings

Note. Adapted from *Blue Ocean Strategy*, by W.C. Kim and R. Mauborgne, 2004, Harvard Business Review.

perceived negative aspects (cost, infeasibility, durability, limited use, storage) of conventional fall protection such as guardrails, nets and personal fall arrest systems.

Safety professionals who want to practice intra-preneurship within their organizations can work within the confines of the accepted methods of fall protection, guardrails, nets and personal fall arrest systems, but focus on self-retracting lanyards because of their versatility and other attributes (Cannon, 2014). OSH professionals can redefine fall protection through an eliminate-reduce-raise-create grid (Figure 2).

By separating the use of guardrails and nets from the implementation of personal fall arrest systems, safety professionals can create a new value curve based on low cost, versatility, ease of use, cost savings (insurance premiums) and feasibility (Figure 3).

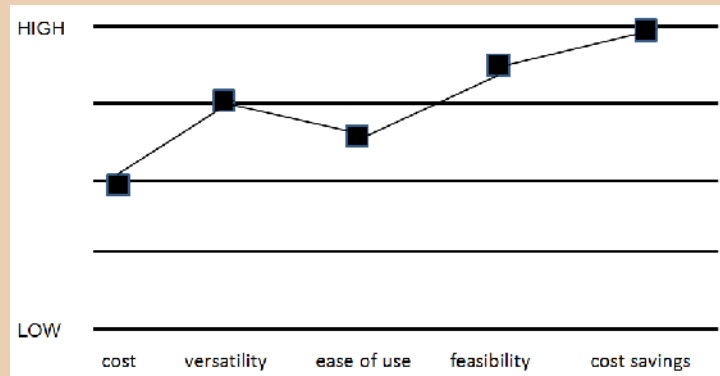
Another important consideration for leadership is, as John Donne wrote, “no man is an island.” A leader cannot change the direction of an organization alone and no single person in the organization behaves without influencing others in that organization. Organizational success is a team effort dependent on the efforts and support of all members of the organization. That said, understand that setbacks will occur and even perhaps passive and/or active resistance to the changes initiated. As John LeBlanc says, “All failures start from the top and when you win it starts from the top” (NIOSH, 2015).

Accordingly, with a top-down commitment by management leading the culture change, resistance and doubt can be overcome through continued active guidance aimed at changing the culture. While upper management should manage the ongoing process of guiding the organization to ultimate success, the entire team need not fail because one or several people cannot get on board. If resistance by workers and managers impedes advancement of the goal, and guidance no longer compels compliance, then management must accept that those resisting may need to be terminated.

While it may seem harsh, the reality is that as long as opportunity for improvement is provided

FIGURE 3

Fall Protection Value Curve as Defined by OSH Professionals



and reinforced prior to termination, those who remain will perceive the termination as supporting the desired culture and the organization will be stronger for it. Owners and management must remember that the ultimate goal in implementing fall protection into the workplace is to keep workers safe and free from hazards that cause serious injuries and deaths.

Conclusion

OSHA rescinded the interim fall protection guidelines and, for the past 5 years, has continued to provide support and guidance to help industry protect workers using feasible and cost-effective systems through consultation and enforcement activities. More resources and guidance than ever are available to residential and light commercial employers. Unfortunately, some employers look at the OSHA requirements and still do not understand how to bridge the gap between long-standing inaccurate paradigms and the truth.

Fall protection is both financially and technologically feasible, and is definitely not a greater hazard than death. Employers and OSH professionals should look at fall protection requirements not as prescriptive rules they are being forced to follow, but rather as guidance to use in their efforts to keep workers safe. Some may be tempted by the adage that failure to follow regulatory compulsion is a business decision that should not be taken personally. For those who have been on the receiving end of an incident that caused injury or death, the business decision is very personal. To say otherwise marginalizes the lives lost during the continuing struggle to improve worker safety.

As long as workers are at risk, OSH professionals must continue to be the experts in protecting workers. We should not rely on OSHA to compel innovative methods that will facilitate our responsibility to provide a place of employment free from recognized hazards. That job belongs to OSH professionals and the profession. We must think beyond regulatory compulsions, keep abreast of

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technology, and create work practices that promote and ensure a safe work environment.

“Each employer, shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees” (OSHA, 2014). Those are not just words but rather a mandate of moral and legal responsibility. If we truly understand the implication and power of that statement, then we will think beyond the nuance of all the different OSHA standards. We will look at a situation and know what it will take to keep the workers safe, and then we would just do it without reservation.

Workers have been saved because of efforts to change the paradigm regarding fall protection in the residential/light commercial construction industry. To anyone who proclaims that the industry cannot provide fall protection, I say that is wrong. We can do it, we did it, and you can, too. **PS**

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