PrePlanning for Rescue at Height: The Next Step in Your Managed Fall Protection Program

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Introduction

In 1997, a 26 year old Nebraska man fell from the vertical side of a structure while performing maintenance work. Fortunately, the man was wearing a fall arrest system and his fall was successfully arrested, leaving him suspended in his safety harness. A co-worker and other rescuers quickly lowered the fallen worker to the ground and transported him to a medical facility where he was treated for a mild strain/sprain, and then released.[1]

His appropriate use of a safety system and the quick, efficient response of his associates saved his life. Many employees who take a fall at work are not so fortunate.

Just a few years earlier, in 1991, an employee in Illinois slipped and fell while performing a similar type of work. His fall, too, was caught by his fall arrest system and he was left suspended fifty vertical feet above the ground. Rescue, however, was not so quickly initiated in this case and the worker died from compression asphyxia while hanging in his harness. His death was directly attributed to the delay in rescue.[2]

According to the U.S. Bureau of Labor Statistics[3], non-fatal injuries and illnesses involving falls in private industry totaled 255,750 in 1995. In another 735 instances that year, falls from height resulted in death. This adds up to 256,485 incidents where a fall resulted in the need for some sort of response, rescue, or recovery effort.

The majority of workplace falls, of course, are relatively simple “slips and trips” such as might occur on any walking surface, office place, or stairs. These types of falls are typically not catastrophic but are notable in that they may result in injury and/or time lost from work. Beyond these, many workplaces also employ individuals who work at or near the ‘vertical dimension’ in workplaces that involve elevated construction, large machinery, catwalks, container tanks, and other raised surfaces. Falls in these environments are much more likely to result in greater injury, or even death.

Section I: Analyzing the Unique Concerns Related to Work and Rescue in the Vertical Environment

Falling

Most of the fatal falls that occur in the workplace are the result of the decedent worker's not having utilized any means of fall prevention or arrest. In a disturbing number of cases the worker is actually wearing a safety harness, and perhaps even a lanyard, but is not clipped in to anything. Unprotected falls from elevated work surfaces frequently result in the individual's impacting the ground, clearly negating the need for any complicated rope-rescue response effort.

But what about those incidents in which the worker is left stranded at height – the result of impacting an elevated surface, for example, or perhaps simply left suspended in their safety harness?

Can your organization ensure the rescue of a fallen worker within 4-6 minutes? How about 15 minutes? If not, you may be gambling with your OSHA compliance and jeopardizing the very life of your workers at height.

Duty to Provide Care

On a chilly, grey day earlier this year (2008) two experienced linemen perched atop a pole in Pennsylvania for two and a half hours waiting for rescue[4] after their work platform failed. Unable to self-evacuate and separated from the ground by 130 vertical feet, one clung tightly to a tower arm while the other balanced precariously on a very thin power line.

Unable to rescue themselves, the men needed help from an external source. The local fire department was called, but didn't have ladders long enough to reach the pair. They positioned a giant air mattress below the workers as a precaution, and then began reviewing their slim list of options. Eventually, a Coast Guard helicopter was summoned and, despite gusty winds and unstable weather, a winch-rescue technique was used to pluck the men from their shaky predicament fully 150 minutes after the ordeal began.

OSHA 1910.151(b) requires that "*In the absence of an infirmary, clinic, or hospital in near proximity to the workplace which is used for the treatment of all injured employees, a person or persons shall be adequately trained to render first aid.*"[5]

In a 1994 Interpretation letter[6], OSHA addressed the concept of near proximity with the following language: *" In areas where accidents resulting in suffocation, severe bleeding, or other life threatening or permanently disabling injury or illness can be expected, a 3 to 4 minute response time, from time of injury to time of administering first aid, is required. In other circumstances, i.e., where a life-threatening or permanently disabling injury is an unlikely outcome of an accident, a longer response time such as 15 minutes is acceptable."*

"Where first aid treatment cannot be administered to injured employees by outside professionals within the required response time for the expected types of injuries, a person or persons within the facility shall be adequately trained to render first aid."

While this interpretation does not necessarily represent OSHA Policy, it does provide a good example of how OSHA might have interpreted the situation described above had these men been in imminent need of first aid.

Rescue of a fallen worker in the construction trade is specifically addressed in 29CFR 1926.502 (d) (20), which reads: *"The employer shall provide for prompt rescue in the event of a fall, or shall assure that employees are able to rescue themselves."*

On the general industry side, rescue of a fallen worker is addressed in 29CFR 1910.66 App C Sect I (e) (8) which states: *"The employer shall provide for prompt rescue of employees in the event of a fall or shall assure the self-rescue capability of employees."*

Excellent guidance for incorporating rescue after a fall into a "Comprehensive Managed Fall Protection Program" is provided for general industry in the new ANSI Z359.2[7], released in 2007. Recommendations in this paper for developing a Rescue Plan (Part II) are based largely on that work. While Z359 does not apply to the construction industry (presently served by ANSI A10.32) similar considerations can be applied to preparation for rescue in any vertical environment.

Effects of a Fall

Numerous projects have undertaken to identify and explore the specific concerns and injuries relating to fall arrest. Harness use is arguably assumed to have originated in Europe, probably stemming from recreational use where falls (belayed using dynamic climbing rope) often exceed 10' and generate up to 12kN force. Harnesses are currently regulated in Europe by the PPE Directive and are required to meet CE standards, which permit both sternal and dorsal attachment points.

Our corresponding code in the USA, ANSI Z359.1, also permits both front and rear attachment for various types of vertical work. This is notable because in a comparative study of acceleration during a fall performed by Robert Lassia at the INSA in Lyon, France, and published in 1991[8] it is indicated that the probability and type of injury sustained varies depending upon type of harness and location of attachment point.

To fully appreciate the effect of harness attachment points on the effects of a fall it is important to understand just how a worker is likely to fall. A quick study of OSHA's searchable database of accidents[9] reveals that while some falls are the result of a surface dropping out from a worker (such as a failed scaffold or platform), most falls are the result of a slip or a trip. The former type of fall would result in a "feet-down" fall, while the effect of the latter would be a "head-down" or a tumbling type fall. Regardless of harness type, changing the orientation of fall during descent is not possible.

The good news is that those workers who are wearing a harness and are properly attached to an adequate fall arrest system will most likely be caught before impacting the ground.

The bad news is, that very fall arrest may result in injury.

According to Lassia's tests, the further an attachment lies from the center if gravity of the wearer, the greater the rotational forces and potential of whiplash during a catch. In other words, an attachment far from the center of gravity results in a much more violent catch.

Maurice Amphoux, in a presentation given in 1983[10], contends that a dorsal attachment, above the center of gravity, provides the best protection to the wearer in the event of a fall because it offers "better disposed suspension"; because the thrust of the chin on the chest limits forward flexion thereby protecting the spine; and because it protects the face from the lanyard when falling.

What's An Adequate Fall Protection System?

Industry-specific regulatory requirements notwithstanding, an "Adequate Fall Protection System" must, most importantly, successfully arrest the fall of the user before s/he hits the ground.

In a recent article in Professional Safety Magazine, Richard Epp calls to attention the effective clearance required for common fall arrest systems. According to his calculations, it is most prudent to allow as much as 17.5 feet!

Potential Free Fall	6.0 ft
Energy Absorber Extension	3.5 ft
Height of Harness Attachment	5.0 ft
System Stretch	1.0 ft
SafetyAllowance	2.0 ft
TOTAL	**17.5ft!!!**

One clear disadvantage to the dorsal attachment point is the complexity it adds for the user to connect, disconnect, or make adjustments to the system. In a majority of OSHA investigations where a fall resulted in a fatality, the decedent worker was not connected to a safety system – even though in many of the cases the worker was in fact wearing a harness and had a fall protection system available. This may very well be partially due to the complexity involved in clipping, unclipping, and adjusting a system that is dorsally attached.

In a notable 2002 Australian Supreme Court11 case, a New South Wales worker who was rendered quadriplegic as the result of a fall was awarded over 6 million Australian dollars at least in part "because the hook was not properly connected to the (dorsal) D ring, even though the plaintiff understood that to have been the case."

Other concerns relating to the dorsal attachment are explored in a paper presented by Calgary, AB, rescue professional Mark Denvir12, at the International Technical Rescue Symposium in 2004. Denvir performed research and field trials on the effects of various attachment positions during a fall, noting in his work that with the attachment at the front of the harness the body tends to rest in a reclined position while with a dorsal attachment the body will instead hang leaning forward when suspended. In his research paper Denvir notes that the arrest phase when experienced in this forward-leaning position "can be violent enough to produce damaging hyperextension and/or flexion of the neck. There is also a danger of being thrown into the structure causing damage to the unprotected face". Conversely, during a fall with a frontal attachment a worker has more control of his backup system, is more easily able to keep it relatively taut, and can even grab the lanyard with his hands in the event of a fall, thereby reducing potential for body rotation and whiplash.

As a frequent harness user who has (intentionally) taken falls in a variety of types of harnesses in the name of science, the author of this paper (McCurley) most assuredly would prefer to fall in a harness that offers a near-waist frontal attachment, and would prefer to hang in and self-rescue from a harness that offers a mid-sternal attachment.

Motionless Suspension in a Harness

Regardless of which side of the attachment-point discussion you lean toward, motionless suspension in a harness is a very real threat to be avoided.

In October of 2000 an employee of a cement company in Texas was working on a platform. He was wearing a safety belt when he fell from the platform, but was working alone and wasn't discovered by co-workers until some time later, suspended from his fall arrest system. By the time he was found, he had expired from positional and compression asphyxia, abrasion and contusion of the lower abdomen from the belt compression, and hemorrhage in the neck and left clavicle area.[13]

A 2002 literature study performed by Paul Seddon for the UK Health & Safety Executive[14] did an excellent job of locating and studying pre-existing literature dealing with the effects of motionless suspension in a harness.

In his research, Seddon calls to attention such works as Peter Weber and Gerlinde Michels-Brendel's, *Physiological limits of suspension in harnesses; Optimisation of intercepting devices - Biomechanical stress limits of humans - Appendix 5: Part III: Investigation of personal safety equipment to protect against falls* by R Mattern and R Reibold for the Deutsche Montan Technologie (DMT) ; P Madsen et al and published in Aviation, Space and Environmental Medicine; and *The medical effects of being suspended in safety harnesses* (1997), Bariod and Théry.

The work of Bariod and Théry was originally undertaken with an eye to caving, but in fact the results are applicable to anyone working in the vertical realm and subject to the potential of being suspended in a harness. In their conclusion, the authors caution that restriction of movement or loss of consciousness should reasonably be anticipated whenever a person falls into a safety harness, and they further emphasize that a relatively long period of time spent suspended and motionless can lead to death.

In summarizing this and the other papers reviewed in his research, Seddon concludes that the suspension phase of fall arrest needs to be more adequately addressed, with emphasis on corrective positioning and rescue.

Two years after the publication of Seddon's *Harness suspension: review and evaluation of existing information*, OSHA produced it's own information bulletin for workers in the vertical realm, entitled: *Suspension Trauma/Orthostatic Intolerance*. This OSHA bulletin also addresses the urgency of releasing a fallen worker from suspension as quickly as possible.

Much work still needs to be done in the area of human physiological response to hanging in a harness, and additional research may especially be warranted into the more specific design elements of different harnesses. Most studies to date have tested a limited number of harness styles so as to provide consistency in comparisons between responses of the human test subjects.

It is reasonable to wonder if research results might vary yet further if the harness models tested were of the type specifically designed to suspend workers in a seated position, such as rope access or rescue harnesses.

Perhaps the most recent work done on the topic of suspension tolerance is a study just released by NIOSH (N. Turner, et al) in 2008[15]. The NIOSH study supports a sense of urgency in rescue, and offers additional perspectives on increasing orthostatic tolerance through the use of an extra accessory strap as a support beneath the knees. Interestingly, the NIOSH study showed insignificant differences between survivability times when using the dorsal attachment as compared with the sternal attachment.

Other Hazards in the Vertical Workplace

Not every potential hazard associated with working at height can be identified in advance. Because falls from a height are well established as having a high injury rate, and in fact are well known to be capable of causing severe or disabling injuries or death, any worksite where work at height is being performed should undergo a full Job Hazard Analysis (JHA) as part of the employer's overall safety and health management system.

A JHA is a written document that analyzes job tasks specifically with the intent to identify hazards before they occur.

Key to the JHA is the examination of the relationship between the worker, the task, the tools, and the work environment. Once hazards are identified, the immediate goal becomes mitigation of those hazards - eliminating or reducing risks to an acceptable level.

Fall Protection Work Plan for Marine Hanging Staging (MHS)
Job Hazard Analysis (JHA)

All employees involved in the installation or removal of MHS must review this JHA prior to the initial start-up of work. This plan must be posted in the work site office for the duration of the job. All employees subject to wear fall protection must be trained in accordance with the written plan. Hazards must be corrected or safely controlled before starting work.

Location:	Vessel:
1. Identify potential hazard(s): ☐ Space certified "Safe for Workers" ☐ Adequate housekeeping ☐ Adequate supply of drinking water ☐ Adequate ventilation ☐ Adequate lighting	**2. Identify potential fall hazard(s):** ☐ Deck openings protected ☐ Interior ladder safe to climb ☐ Slip and trip hazards removed ☐ Adequate sole tread on workers' boots ☐ Warning signs posted
3. Describe the hazard(s): **All corrections made: Inspector's initials:**	
4. Attendant's field check of fall protection systems: ☐ Tripod/retrieval system locking capacities ☐ Defects in cable, tripod, hooks, mildew, wear ☐ Chaffing gear on site ☐ Retrieval system inspection data ☐ Body harnesses for supporting workers ☐ Other ______________________	**5. Installer's field check of work platform:** ☐ Harness ☐ Lanyards ☐ Carabiners ☐ Anchor straps ☐ Stirrups ☐ Other support equipment
6. Qualified person's inspection of interior tank structure for safe and secure anchor points: **If structure anchor points are unsafe – Stop Work**	
7. Describe the method for prompt, safe removal of injured workers. ☐ **Call** _______________ **Call 911** **Call offsite rescue number** __________ ☐ **Describe the location of the phone:**	
8. Trained cable installer(s) and attendant(s) on site under this plan:	

Signature	**Print Name**	**Installer or Attendant**
______________________	____________________	______________________
______________________	____________________	______________________
______________________	____________________	______________________
______________________	____________________	______________________

Signatures

Approvals:
Responsible supervisor ______________________ Date of inspection:________________

Qualified person ___________________________

Exhibit 1. Sample Job Hazard Analysis
From *Safe Work Practices for Marine Hanging Staging* (2005)
OSHA Guidance Document

OSHA provides guidance to JHA's through publications[16], consultation assistance, Voluntary Protection Programs, and other resources.

Key components of a well-developed JHA include:

- description of work
- identification of hazards
- implementation of methods to mitigate associated work hazards

Sometimes work in the vertical environment involves exposure to additional hazards, each of which should be individually examined along with the height considerations, specifically in relation to the worker, the task, the tools and other environmental factors.

A JHA should address all situations in which a fall hazard might reasonably be expected, and should also take into account complex environments that may involve other protective or regulatory considerations, aside from fall protection. Such factors may include confined spaces; chemicals; machinery; falling objects; and pre-existing medical conditions of workers. Each of these factors adds a degree of complexity to the worksite, and may involve regulatory considerations beyond and in addition to fall protection requirements.

FALL HAZARDS*

COMMON CONTRIBUTING FACTORS

- Leading edges
- Skylights
- Ladders
- Holes & hoist areas
- Ramps, runways & walkways
- Excavations
- Precast concrete & bricklaying
- Wall openings

*Not a comprehensive list!

Once hazards are identified, hazards should be explored thoroughly to determine whether (and how) they can be decreased or eliminated. The level of risk may be reduced through planning alternative solutions to the work and/or limiting exposures to the fall hazard.

With 'fall arrest' at the highest level on the Fall Protection Hierarchy, it is worth noting that reducing exposure time at height may also have a paradoxical effect in that workers who do not frequently perform a given type of work may actually become less adept in that function.

Some research suggests that as much of 70 percent of a person's knowledge is lost within 2-3 weeks of acquiring that knowledge when it is not used[17]. This would suggest that the average level of retention for a given topic is approximately 30 percent as little as one month after training, *unless that skill or knowledge is put into practice*.

Repetition of a skill has long been recognized as a viable method for reinforcing one's proficiency in that skill. Allowing adequately trained personnel to utilize their skills in working at height builds experience, and skills combined with experience will help reduce the possibility that rescue will be required at all.

Section II: Developing, Staffing and Executing an Effective Rescue Plan

The New ANSI Z359.2 charges the Fall Protection Program Administrator with developing rescue procedures for every location where an active fall protection system is used to control a fall hazard. This is consistent with OSHA's expectations as well.

OSHA 29 CFR 1910.120(q) even takes the concept a step further by requiring entities engaged in emergency response to:

- develop a *written* response plan that includes personnel roles, authority & communications, site security & control, medical and emergency alert procedures;
- provide appropriate training to their workers;
- use an incident command system; and
- provide workers with appropriate protective equipment.

Employers are free to choose whether to use internal or external resources (or both!) to fulfill rescue requirements, the only caveat being that rescuers must be trained and prepared (in advance!) to effect "prompt rescue" of a fallen worker.

Having already created a JHA, the Rescue Program Administrator already has a head-start for developing the required rescue plan. Wherever hazards are identified, the same hazards must be examined from a rescue perspective. Specifically to the concept of working at height, given a particular hazard in the vertical environment, how would you respond in the case of an accident that might result from that hazard? And, how might a potential rescue be impacted by that same hazard (and associated hazards) during the course of the rescue itself?

A well developed site-rescue plan will incorporate and utilize strategies for prompt self-rescue and will also prepare for assisted rescue of any worker who falls. The rescue plan should include:

- - overview of hazards as identified by the JHA
- - arrangements to ensure notification when a fall occurs
- - making contact with the rescue subject as soon as possible after an incident
- - written procedures for self-rescue (if applicable)
- - a plan for summoning the rescue service
- - written procedures for assisted-rescue, including:
  - Identification of rescue personnel who will respond
  - Identification of anchor points to be used
  - Procedural instructions for performing each identified type of rescue
- - Equipment information – selection, care, inspection, maintenance and storage
- - Notes on external resources
- - Training/refresher plans and records

All of the preceding concepts should be included in the Rescue Plan regardless of whether internal or external resources are used.

<u>Developing the Rescue Plan</u>

Where hazards are identified in relation to a fall potential, the same hazards must be examined from a rescue perspective. Working on an elevated surface is one thing; it is quite another to effect a rescue where space, anchorages, maneuverability and egress might be compromised. The same holds true for complex environments. Rescue resources must be trained and prepared to function in the same environment(s) as the subjects that they might potentially rescue, and should also be adequately trained in medical interventions.

Fall Hazards can occur in any vertical environment. Although they must guard against complacency, employees who work frequently in the same location or environment may find some advantage when it comes to planning. Not only does frequent use of skills increase the employee's familiarity with and aptitude for his work, it also makes the rescue planning much easier.

Average Time For Untrained Co-Workers Responding to a Fallen Worker to:

	In minutes
Complete a 911 call	10
Assess victim condition	20
Organize Response	30+

Source: Roofing Contractor Magazine January 29, 2003

Perhaps the most difficult – and the most crucial – moment in the progression of a rescue lies in providing notification to others when an incident has occurred.

Regardless of rescue technique or method, all rescue resources in a given plan should be mobilized as soon as possible, and then 'stood down' if appropriate. This includes making provision for medical care and transport to an appropriate medical facility for observation, even if an 'in house' team is handling the rescue itself.

In a 2003 article for Roofing Contractor Magazine[18] author Chip MacDonald shares his experience that it often takes untrained co-workers up to an hour from the time of incident to even initiate rescue procedures themselves. Quick notification that the fall has occurred can help to reduce this delay and contribute positively to the outcome.

Certainly ensuring that personnel always work in teams will lend itself to expeditious notification, but other controls should also be put into place. Where constant visual monitoring is infeasible, creative use of alternative warning systems, such as the PASS "motion sensors" used by firefighters, may be advisable.

The preferred 'first line of defense' for any worker in vertical suspension is self-rescue. An employee working at height should be adequately trained and equipped to perform self-rescue in the work environments in which he might likely work.

Self rescue is feasible if the following three conditions are met:

- injury does not prevent self rescue
- subject is trained in self rescue
- subject is equipped for self rescue

A written procedure for self rescue should be prepared in advance and personnel working at height should be trained and practice frequently to follow these procedures in the event of a fall. Methods should be simple, should always maintain a secure connection to the safety system, and should require a minimum complement of equipment.

These methods should be practiced regularly, and implemented immediately after a fall if the subject is able. Preparation to ensure this capability requires practice as well as making a habit of carrying the necessary equipment for self rescue.

Self rescue is not a substitute for assisted rescue, however. Even while self-rescue is being attempted, the next level(s) of rescue resources should be mobilized.

NFPA 1670[19] describes response level capabilities in three levels:

- **Awareness Level** - Able to Recognize Incident and Initiate Response.
- **Operations Level –** Able to Respond and Apply Limited Techniques to Support and Participate in Response.
- **Technician Level** – Able to Respond and Apply Advanced Techniques to Coordinate, Perform, and Supervise Response.

These levels may also be considered an excellent guideline for industrial application. Any personnel working in a hazardous environment, including work at height, should be trained at least to the Awareness Level for whatever hazard(s) they may encounter. They should be able to recognize when something has gone wrong, and should be able to call for help for themselves or for a co-worker. Wherever the likelihood for an incident exists, the employer should ensure availability of a Technician level response. Whether this capability comes from internal or external sources is a matter of choice.

Unless an organization employs safety experts who are also experts in rescue, it is advantageous to consult with external resources to ensure that the rescue plan identified is reasonable, practical, and prudent, utilizes appropriate equipment and techniques, and is in accordance with regulatory considerations.

Depending upon the source referenced, rescue planners will find advice for rescuers to make contact with the rescue subject anywhere from five to 15 minutes from the time of the incident. In order to ensure that no more than 5% of subjects experience medical symptoms resulting from suspension intolerance, the previously referenced NIOSH[20] study suggests that rescue within seven to 11 minutes is imperative.

If the subject is unable to rescue himself, even on-site rescuers will be challenged to meet this recommended time frame. Very specific written procedures should be developed for every potential rescue scenario identified. Rescue from fall protection will generally involve some type of vertical or high angle rope system, so the plan should identify:

- anchor points to be used
- anchor rigging methods
- equipment to be used
- equipment rigging methods
- complete instructions for performing each identified type of rescue safely and promptly

The plan should provide clear guidance on anchors to ensure that rescuers know the capabilities and limitations of all anchorages – particularly where a system might be used to support two people. Anchorages selected for rescue systems should have strength capable of sustaining static loads, applied in the directions permitted by the rescue system, of at least 3,100 pounds or meet a 5:1 safety factor based on the static load placed
on the system.

Direction of travel and potential pendulum issues should be taken into consideration when developing rescue plans for specific sites. Simple retrieval systems commonly use a single anchor

– perhaps even the original fall arrest anchor. For more complex rescue scenarios, a secondary anchor, and perhaps even an entire backup system, may be more appropriate.

Rescuers should be cross-trained in multiple aspects of performing the rescue so that each job can be done by more than one person and to facilitate “safety checks”. Wherever possible, “non-entry retrieval methods” should be used to avoid exposing rescuers to additional hazards. Rescuers exposed to a fall hazard must be provided an anchorage suitable for fall arrest in accordance with ANSI Z359.1.

In rigging any rope system, care should be taken to protect the vertical lifelines from abrasion, sharp edges, or contact with any structure that might adversely affect their function. Ropes must also be protected from entanglement.

Mechanical advantage may be provided in rescue systems by means of winches, hoists, and pulley systems. The rescue plan should take into consideration provision for appropriate mechanical advantage to accommodate one person or two person loads for extended raising or lowering operations. The plan may vary for different rescue sites.

Equipment

To the extent possible, rescue systems should be simplified and pre-rigged. This helps to avoid any confusion or errors due to the natural ‘urgency’ of a rescue, and also helps to reduce the amount of information/skill a rescuer must retain. Equipment should be stored in a ready-condition within easy access of potential rescue sites. If necessary, equipment should be protected from environmental conditions that could damage it.

Some employers may find it necessary to maintain multiple ‘rescue kits’ cached in key locations in order to ensure that rescuers have access to the equipment they need within a few minutes of any work location.

Equipment selected should be intended for the application in which it is planned to be used. Rigging recreational climbing equipment together for the purpose of rescue is fine on a holiday excursion to the mountains, but would be considered negligent in the workplace. All equipment should meet appropriate life safety equipment standards, such as Cordage Institute, ANSI, NFPA, or ASTM.

Life safety ropes should meet Cordage Institute standards for life safety rope, or NFPA standards for rescue rope. Modern life safety ropes are generally of a kernmantle construction, negating the ability to splice “eyes” into the ends for connection. Kernmantle 11mm ropes meeting Cordage Institute standards have strength ratings of at least 6000lbf. It is acceptable to utilize knots in the rigging of these ropes for rescue, so long as the knots used do not reduce the strength of the system below the required *system* strength to ensure an adequate safety factor.

Knots commonly used in rescue applications have been shown to reduce the strength of a rope by approximately 25-30%.[21] This means that an 11mm kernmantle knotted rescue rope can be expected to withstand 4200lbf – making it 1200lbf stronger than the anchor to which it is attached.

ROLLOUT
"Rollout" is a phenomenon, caused by incompatibility between rigging components, in which two pieces of equipment can become unintentionally disconnected through a twisting action.

Connectors meeting the requirements of ANSI Z359.1 are considered appropriate for retrieval operations. For actual rescue application, connectors meeting rescue-specific standards such as NFPA 1983 may be preferred. Whether integral to a system or used individually, as components, compatibility with other parts of the system is critical. Rescuers in the planning and in the execution phases should be particularly sensitive to guarding against the phenomenon known as "rollout".

Harnesses used for rescue may differ from those used for fall arrest and positioning. Rescue harnesses should be designed and fitted to the user so as to be comfortable when worn properly, allow mobility for working, and be reasonably comfortable to hang in when affecting a rescue. Different users may find personal preference for different harnesses based upon body shape and size, familiarity, or other factors. These preferences must be balanced with the consideration that consistency and uniformity in equipment can contribute positively to safety by introducing a certain 'regularity' into the task of checking one another's equipment, rigging, and systems.

Equipment should always be stored, maintained, and used according to the manufacturer's guidelines, and system compatibility must always be taken into consideration. Using equipment for purposes other than might have been intended by the manufacturer is a hazardous and imprudent practice. Ideally, all elements of the rescue system should be specifically designed to work together, and should be customized as appropriate to the worksite.

Staffing the Plan

Rescuer safety is always of the utmost importance.

Whether responding from inside or outside the facility, the designated emergency responders should be mobilized immediately in the event of a fall – even if all indications suggest that the subject will successfully self rescue.

The team should consist of personnel who are familiar with the facility and the type of equipment being used for fall protection, and who have trained and practiced for this type of response. Ideally, no fewer than four responders should be available at any given time.

If an organization anticipates using external resources to provide rescue services, the employer's competent person or program administrator should contact the rescue agency before the commencement of any work at height. Together these should review the location of the elevated workplace, the types of fall protection being used, and complete information regarding the environment where the agency may be called to perform a rescue.

It is incumbent upon the employer's Program Administrator to secure written notification from the rescue agency as to availability, capability, any limitations on the types of rescue it can perform, detailed instructions regarding how they are to be called, and any special instructions (such as notice of work, response times, etc). It is up to the employer and the program administrator to determine which aspects (if any) of worker rescue are within the capabilities of an external rescue agency. The program administrator must also ensure that personnel working at height are aware of the procedures for summoning the rescue agency and any other information necessary to launch a successful response.

Where outside professional rescue agencies cannot be relied upon to promptly rescue a fallen worker, the employer may choose to hire a “standby rescue team” from an external source, or may prefer to train a selected group of his own employees as rescuers.

Rescuers expected to respond to workers suspended in a vertical workplace should have at least the same level of worksite training as the personnel they may be rescuing, plus knowledge and ability required to assess the worksite and develop an appropriate rescue method. They must be adequately prepared to switch from ‘work-mode’ to ‘rescue-mode’, including being able to quickly don, doff, adjust, and properly use rescue-specific equipment. Ability to understand how to properly inter-connect equipment and use it according to its purpose is key.

Rescue personnel must have familiarity with not just the vertical work and equipment, but must also possess a certain amount of medical capability. Knowing how to protect the fallen individual from further injury and transition the subject from the extrication phase to the transport phase for transfer to a medical facility are important aspects of the rescue process.

Responders who may rescue workers from a suspended situation should be aware of both the physiological aspects of suspension trauma that have been observed by researchers during both the suspension phase as well as the post-suspension phase. All studies relating to suspension trauma have noted that matters are made much worse when the subject hangs motionless.

To reduce the effect of both suspension and post-suspension shock, rescuers should encourage the subject to move their legs in the harness and try to push against any footholds, or even to adjust their position to a sitting posture with legs up as high as practical, during the course of the rescue.

In the NIOSH study, suspended persons supplied with a prototype harness accessory that raised the knees of the subject and provided additional support increased suspension tolerance to over 58 minutes – twice the average duration without the support. This has practical implications not just for the hang, but also for the recovery process.
In early 2007 the HSE released an addendum[22] to Seddon’s work noting further complication that may lead to suspended casualties dying after being rescued (rescue death). This is caused when the person is put into a horizontal position too quickly, resulting in a rush of the de-oxygenated and possibly toxic blood pooled in the legs to the heart, causing heart failure due to overstrain.

As a result of this finding it is recommended that rescuers take at least 30 minutes to move the rescued worker from:

1. An upright position;
2. To kneeling;
3. To sitting; and finally,
4. To a prone position.

The process helps to avoid sudden blood flow to the heart after removal of a worker from a suspended position. Of course, any worker who has experienced post fall suspension should ultimately be taken to a hospital for observation.

Executing the Plan

Training and competence are key factors in preparing for any successful rescue, even professional responders. This is even more true for a para-professional rescuer, who may not have frequent enough opportunity to exercise is his/her rescue skills in the field.

Many companies cross-train a select number of employees for in-house rescue response, and this can be a successful model to follow. These rescuers should be well trained and should be given opportunity to practice often the types of rescue interventions that they might be expected to perform. Just practicing or using his/her vertical skills during the normal course of work is not sufficient to prevent rescuer skills from becoming rusty.

In developing any rescue capability, one, and only one, of the designated responders should be assigned as 'leader'. A designated Rescue Leader will save time and increase the safety and efficiency of a rescue. The Rescue Leader should be experienced and capable, should know his designated rescuers and their capabilities, and should be able to immediately implement a structured 'command system' that can grow and expand with the variable scale of an incident.

The Rescue Leader should have excellent knowledge of the written Rescue Plan for each type of anticipated rescue identified by the JHA, and in fact may have been involved in the development of the plan.

Prior to performing rescue work, rescuers must be proficient in emergency rescue planning as well as be capable of their own self-rescue. Lecture, demonstration and hands-on practice are all appropriate methods of training, particularly when combined. Appropriate rescue training will include use of all types of equipment and systems commonly used in locations where rescue may be required. Rescuers should be familiar with inspection of both work and rescue systems prior to use, installation, component compatibility, descent control, secondary systems, patient packaging, dismantling, storage and common hazards associated with each system and component.

Designated emergency responders should receive refresher training annually, and should demonstrate their working knowledge of rescue skills through drills in the normal work environment at least monthly. Ideally, periodic assessment of rescuer skills shall be conducted at least annually by an external professional. Such 'active learning' will help keep responders ready to perform difficult duties when the need arises.

Competent Rescuers Should Understand…

- fall hazard elimination and controls;
- applicable fall protection and rescue regulations;
- assessment of fall hazards to determine rescue methods;
- responsibilities of designated persons
- detailed inspection and recording of rescue equipment components and systems;
- rescue system analysis and safety checks;
- development of written fall protection rescue procedures.
- selection and use of noncertified anchorages.

Additional training should be provided whenever a new component or system is introduced, whenever a new condition of use is introduced, or whenever special conditions may be encountered. If there is potential for a response to be needed in inclement weather, at night, or under other additionally challenging circumstances, these should be practiced repetitively as well.

Psychological as well as physical challenges should be considered as part of the training process. In-house rescue personnel may very likely be responding to incidents that involve acquaintances, friends, or even family – adding even greater pressure to an already stressful situation. Resources for Critical Incident Stress Debriefing[23] should be maintained as part of the Rescue Plan and made available to personnel following any incident.

Summary

OSHA reports that more than 100,000 job site falls occur annually. At the very least, the majority of fall injuries (85%) result in lost time. At worst, falls account for up to 12% of all fatal work injuries in the United States.

Today, an inclusive Rescue Plan as an integral part of an employers' Comprehensive Managed Fall Protection Program is more than just "compliance". It is part of a foundational "safety culture" that breeds Business Excellence and Competitive Advantage[24].

With the information and resources available today, a 15-minute or less response time to a fall incident is fully achievable. Make Planned Rescue part of a Comprehensive Fall Protection Program that contributes to your Strategic and Financial Corporate Goals.

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