

## 2) ISSUES RELATED TO THE WEARING OF FALL-ARREST HARNESSSES IN THE CONSTRUCTION INDUSTRY.

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### ABSTRACT

Work-related falls continues to be one of the leading causes of fatalities in the Australian construction industry, and the failure to use fall protection equipment, such as fall-arrest harnesses and arresting devices, has been found to be a contributing factor. In an attempt to gain an understanding of the issues surrounding the use of fall-arrest harness systems by construction workers a study involving semi-structured interviews of 15 male construction workers was carried out at three construction sites. The majority of interviewees commented that there was discomfort in wearing a fall-arrest harness; that there were a number of problems when anchored via an arresting device; and that using a fall-arrest system reduced productivity. Most of the interviewees considered that they needed safety precautions against falls, and they expressed the view that workers' attitudes towards safety depended critically upon their supervisors' attitude towards safety. It was also found that workers were not trained in rescue procedures. Interviewees expressed concern that retrieval of a suspended worker may not be carried out in time to prevent the onset of suspension trauma. A number of issues were identified which require further research, such as, investigation into suspension trauma, harness and arresting device design, training provided to workers, and the provision for rescues.

### INTRODUCTION

In December 2002, a construction worker died at the University of Queensland after falling from a partly collapsed swing stage scaffold. The worker was not wearing a fall-arrest harness despite this being required by site policy. This incident prompted an examination of the issues associated with the wearing of fall-arrest

harnesses during construction work at heights. Clearly it was not an isolated case as between 1989 and 1992, 12% of all work-related fatalities involved falls, of which 66 fatal falls occurred in construction in Australia (NOHSC, 2000). Similarly, work-related fatal falls are the leading cause of death in the US construction industry (Janicak, 1998). Both reports found that the failure to use fall protection equipment, such as fall-arrest harnesses and associated arresting devices, was a contributing factor.

Possible reasons for workers' reluctance to use a fall-arrest harness system are given by Hamilton (1987) and Rushworth and Mason (1987) as:

- putting on a fall-arrest harness can be awkward and difficult;
- wearing a fall-arrest harness can cause a feeling of discomfort and movement restriction;
- fearing that harness strapping between the legs could impact the groin area;
- feeling irritated by the restricted mobility caused by the lanyard's length, and the type of anchorage;
- fearing that restricted mobility might cause accidents (particularly tripping);
- knowing that fall-arrest harness systems may reduce work efficiency;
- thinking that "it won't happen to me".

Others (Suruda et al, 1995) have suggested that supervisors' attitudes towards safe work practices, and the workers' perceived conflict between productivity and safety, may influence the use of fall-arrest harness systems.

### METHOD

This project used a survey method to gain an understanding of the issues surrounding the use of fall-arrest harness systems by construction workers. An interview schedule based on previous research was used in the semi-structured personal interviews of 15 male staff working on three commercial construction sites. The participants were chosen to provide a diversity of occupations and experiences with fall protection devices. Table 1 lists the occupations of the participants. All except one painter/renderer were considered experienced workers of their occupation. The interview schedule was used as a guide only and the interviewees were encouraged to talk about any issues which they considered relevant to the use of fall-arrest harnesses. The interviewees' responses were recorded during the interview. All responses were then categorized and summarized.

Participant	Occupation
1	Carpenter
2	Crane Driver
3	Demolisher
4	Painter/Renderer
5	Painter/Renderer
6	Roofer
7	Rigger
8	Rigger
9	Scaffolder
10	Scaffolder
11	Scaffolder
12	Safety Officer
13	Safety Officer
14	Site Supervisor
15	Supervisor (Scaffolding)

## RESULTS

Responses to interview questions and other comments made by interviewees were summarized and grouped under the following subsections:

### 1. Fall-arrest harness:

Most interviewees could not recall the brand names of the different fall-arrest harnesses that they had used. About half the people thought the fall-arrest harnesses were all similar, while the remainder thought that some were better or more comfortable than others. A few people could recall the brand name of harnesses which they considered better than other brands, and a couple expressed a preference for rock climbing seat harnesses.

In the majority of cases employers supplied workers with fall-arrest harnesses, or the harnesses came with the machinery (for example, with boom lifts or Cherrypickers). Two of the workers (riggers) commented that they purchased their own harness. Fall-arrest harnesses (and the associated equipment) were said to be expensive, and difficult to hire.

The length of time fall-arrest harnesses were worn was variable and highly work dependent. Fall-arrest harnesses might be worn for only 5 minutes, or for 8 hours a day. The riggers, roofers and scaffolders commented that they wore fall-arrest harnesses "all day", while the carpenter, painter/renderers, demolisher and crane driver only wore fall-arrest harnesses "occasionally".

Almost all interviewees commented that fall-arrest harnesses are easy to put on "when you know how", although "some are easier than others". One person commented that it "can be awkward...the straps are different ... [it] gets tangled up ... some get more tangled up and twisted than others". They said that all fall-arrest harnesses are fully adjustable and adjusted to fit when

they are put on. One person commented that workers "don't wear the leg straps"; another said he "often sees guys with a fall-arrest harness on that's not fitted properly — the leg straps are very loose".

Most people said they experienced discomfort while wearing a fall-arrest harness. Only two indicated that there was nothing particularly uncomfortable about wearing a fall-arrest harness, if time was taken to adjust it properly. A few people noted that wearing a harness caused some discomfort but it was not unbearable and wearing it was preferable to a fall. Issues of discomfort included:

- straps at the groin area;
- overall bulkiness;
- difficulty bending down and crouching;
- harness being hot and itchy in summer; and
- pulling the line from the retracting arresting devices. *{It was not clear whether this was actually a harness discomfort issue or a lanyard nuisance issue ... just tiring pulling the line out of the arresting device, or that while pulling out the line, the harness straps would dig into the body.}*

Finally, one person noted that "you really know when you've had it on all day".

Almost all the interviewees commented that there was nothing specific about the fit of the fall-arrest harness which made them unwilling to wear it. When the people were asked what other workers felt about wearing a fall-arrest harness all but one person said that some or most others did not like wearing it for similar reasons as those expressed by the interviewees. Two people commented that other workers complained about the extra time needed to put on a fall-arrest harness, especially for short, quick jobs.

When asked what they considered was the biggest problem with a fall-arrest harness, the workers said:

- interruption to concentration because attention is constantly on the line[lanyard/arresting device];
- lack of a decent anchor point to take the weight of a fall;
- discomfort and movement restriction;
- concern about a tourniquet effect of leg straps when suspended, and the necessity for quick retrieval;
- lack of training; and
- lack of access to readily available hire of fall-arrest harnesses.

When asked what design improvements could be made to fall-arrest harnesses, the following issues were identified:

- comfort of the leg strapping;
- harness straps having excessive length past the buckles and the ends not being smooth;
- fit of the fall-arrest harness while bending;
- tourniquet effect on the legs when suspended via the rear attachment;
- multiple joins increasing potential weaknesses;
- difficulty donning the harness.

A "seat fall-arrest harness" or "rock climbing fall-arrest harness" was suggested as an alternative design strategy.

## 2. Lanyards/arresting devices:

Depending upon the work situation, either fixed length energy absorbing lanyards (1 or 2 at a time) or retracting lanyards/inertia reels were used. Fixed length lanyards were used in boom lifts, Cherrypickers, and attached to static/running lines (anchorage lines along which the lanyard can slide).

A few interviewees expressed a preference for fixed length lanyards when used with static/running lines, saying they had no problems with running lines, although inertia reels were a problem because they were likely to jerk to a stop "out of the blue" and lockup if the person was moving quickly. However, others expressed a preference for inertia reels and retractable lanyards as opposed to fixed length lanyards.

All interviewees used the attachment hardware at the back of the fall-arrest harness, and in almost all cases the lanyard was already attached before the fall-arrest harness was put on. Two workers claimed to have seen other workers using the side attachment points (on the harness), because "it's easier to clip to the side rather than the back". Others noted that those who are unfamiliar with fall-arrest harnesses may try to put the fall-arrest harness on first and then attach the lanyard and climb into position before attaching to anchorage. Two people considered that it depended on the situation, and they put the fall-arrest harness on before attaching the lanyard. Those who donned the harness before attaching the lanyard either got someone else to make the attachment at the back, or using both hands, reached behind to attach the lanyard themselves and gave it a pull to check that it was attached. It was said that "you know if it's attached, it's either on or off". However, one person added that he had seen many people wearing a harness while working which was not attached to an anchorage, saying "most people don't bother to attach".

The various problems identified with lanyards/arresting devices and anchorage were that:

- lanyards get twisted and only turn one way;
- fixed length lanyards attached to fixed point anchorages always drag behind, get in the way, and are a trip hazard;
- they frequently get caught and tangled on protruding objects;
- some lanyards require frequent connection and disconnection from anchorage points;
- lanyards may drag and snag on something and unbalance a worker on a beam;
- lanyard anchorage hooks may be too small to fit and properly close on the anchorage;
- inertia reels cause discomfort when pulling out the line;
- very long inertia reels may be difficult to connect at the back of the harness, and the attachment may be difficult to screw shut;
- there are too many fixed point anchorages;
- fixed length lanyards restrict movement and cause worker irritation; and
- attending to the lanyard may interrupt a worker's concentration and momentum.

Anchorage points were said to be readily available on boom lifts, scissor lifts, and Cherrypickers. There were mixed responses about anchorage availability on structures. While construction is in progress anchorages may not be a problem, although installing the static/running lines may have to be done with little fall protection because access via boom lifts may not be possible. Some of the interviewees expressed a concern about the lack of available anchorages. Some roofs and older buildings may have little or no anchorage available, and accessing the outsides of some buildings for work and maintenance can be problematic. One person said workers had to drill and dynabolt their own anchorage points. A worker questioned which entity should bear the cost of installing anchorages if none were in place at the start of a job. Another person commented that often anchorages are suspect and may not be engineer approved, and most significantly, may not support the weight of a person during a fall.

### 3. How work is affected when using a fall-arrest harness system:

A few interviewees (two of whom were working in Cherrypickers) commented that wearing a fall-arrest harness had no affect on their work. One person expressed the opinion that "being in a dangerous position you should slow down anyway, be slow and methodical". However, most of the people said that wearing a fall-arrest harness did affect their work in the following manner:

- breaks concentration, and the worker is always conscious of the lanyard/arresting device;
- interrupts flow of work and reduces work productivity because of dragging, hooking and unhooking from anchorage, untangling (from things and other people) and disconnecting the fall-arrest harness straps when they become caught; and
- increases frustration and irritation.

### 4. Experience of being suspended or falling while wearing a fall-arrest harness:

Only one interviewee had experienced being suspended while wearing a fall-arrest harness as a "trial". Most of them had not heard of anyone having a "trial" suspension in a fall-arrest harness.

The one person who had experienced a trial suspension (for approximately 2 minutes) in a fall-arrest harness, where back attachment hardware was used, described it as being very bad and painful. Another person described his experience of slipping down a steeply pitched roof while wearing a fall-arrest harness as not comfortable.

Four people said that they had been advised by safety equipment sales representatives, safety officers or others, not to hang in a fall-arrest harness for periods of more than 7 to 16 minutes. It was said that the suspended person's blood circulation could get cut off because the fall-arrest harness straps put pressure on the upper leg/groin area, and "your internal organs get pushed around". One person claimed that the potential for being injured by suspension in a fall-arrest harness was general knowledge, and was of concern to workers.

### 5. Training:

Most of the interviewees received some basic training from an accreditation program (for example, from a construction training course or equipment training course), and the training was said to include:

- how to put on and adjust a fall-arrest harness;
- when to use a fall-arrest harness;
- how to use safe anchorage points;

- how to check the age and state of the harness; and
- regular checking for any deterioration in the harness.

Three of the interviewees claimed they had not received any formal training, but were self-trained having also learned by "word of mouth."

Three supervisors or safety officers stressed the need for more training and stated that lack of training in all aspects of fall-arrest harness usage, and installation of anchorages, was a major problem.

### 6. Attitudes towards safety:

All interviewees commented that they checked the harness for excessive wear, fraying, cuts or tearing, faulty stitching, and the fall-arrest harness date. It was said that "a quick look would tell you if it's OK", although two people did not believe that other workers would check their fall-arrest harness before putting it on. Two others commented that their employer inspected the fall-arrest harnesses. Another person said "our fall-arrest harnesses were inspected three weeks ago and a lot were condemned".

Almost all interviewees indicated that they personally felt the need for safety precautions to avoid falls. A couple of workers quantified this comment by saying that some jobs were more unsafe than others, and that they did not believe that harnesses were needed if working in a "basket" (boomlift or Cherrypicker). And again, almost all considered that Workplace Health and Safety precautions to prevent falls were worthwhile. One worker noted that there were now lots of precautions whereas eight years ago there were none in place.

Four interviewees gave estimations that a sense of bravado and invulnerability probably described between 20% and 50% of other workers' attitudes towards safety. It was further suggested that some of this attitude (the worker described it as "self confidence") was probably necessary to carry out rigging work. However, three workers insisted that there were only a minority of such "cowboys" in their own peer group.

A few interviewees also claimed that workers' couldn't be bothered to wear a fall-arrest harness. Some workers reported hearing other people say they had gone without a harness hundreds of times without falling; or that the person was in too much of a hurry to get the job done to bother stopping to wear a harness. These attitudes towards hazard avoidance appears to be balanced by a "safety first" approach by other people. Two people claimed that their workmates were less careless than they were in the past, and that 50% were now safety conscious.

About half of the interviewees expressed a preference for edge protection and handrails. A few commented that all of the fall protection systems were useful in the right work situation.

The majority of interviewees commented that their supervisors' attitude towards safety influenced whether fall-arrest harnesses were worn by workers: one saying that the "supervisor's attitude is critical to workers' attitudes toward safety". Another person noted that if a supervisor pushed safety concerns the workers would be unlikely to argue, however, another person commented that supervisors did not enforce the wearing of fall-arrest harnesses consistently, as is required. It was suggested that subcontractors often skirt safe practices to save time and money. A couple of interviewees said that they were not influenced by supervisors who were not safety conscious as they relied on each other to reinforce safety matters.

All interviewees said that their employer had safety procedures and policies in place. All but one person claimed that their employer enforced the safety procedures and policies, although one person qualified this significantly by adding that supervisors could not watch workers 100% of the time.

About half of the interviewees commented that there were boom lifts, scissor lifts or elevated platforms available on the work site which could be used to retrieve a suspended worker. One person, however, qualified this comment by saying that it may not be possible to access some areas with these machines, and he was concerned whether a rescue could be implemented fast enough. The remaining half commented that there was no-one trained to rescue, there was no rescue plan in place, nor did they know of any rescue plan being in place. One person noted that rescuing a person suspended from a swing stage scaffold was a major problem. The lack of training was the reason given by another person for the disinclination of some people to acknowledge the need for a rescue plan. Yet another person commented that there was awareness by management of what to do if a worker was suspended in a fall-arrest harness, but also said that there was no one trained in rescue procedures.

## Discussion

A number of factors which have a negative impact on a workers' willingness to use a fall-arrest harness system are evident in the above results.

Factors which are specific to the fall-arrest harness design include:

- workplace awareness that being suspended in a harness for a length of time could be physically damaging, and that fast rescue is necessary;

- harnesses may prove awkward to put on and bothersome to wear for occasional users;
- strapping around the legs may be uncomfortable and result in the harness being unused or fitted loosely or inappropriately; and
- harness discomfort may be variable across harness brands.

Factors which are specific to the lanyard/fall-arrest device and anchorage:

- different types of lanyards/fall-arrest devices may present a number of problems for workers, and feelings of frustration and irritation caused by these problems may result in the workers not attaching their harness to an anchorage;
- a fall-arrest harness system may not be used where there is a lack of anchorage on some work sites;
- workers may consider that they become slower and less productive because they are attached to an anchorage and may be tempted to do the work without being anchored.

Other factors:

- possible problems getting access to fall-arrest harnesses and arresting devices on short notice, or for small jobs, that may result in workers not using a fall-arrest harness system.
- some workers may place less importance on safety precautions against falls and be influenced by their past experiences of not falling while doing the work, or hearing of someone else falling;
- workers may assess the level of danger in work situations differently and may consider that use of a fall-arrest harness system is not important in some situations;
- a small proportion of workers may not wish to co-operate with established safety regimes;
- workers may be influenced by supervisors who are not 'safety conscious' and do not actively police and enforce safe work practices; and
- the frequency of worker training in all aspects of the use of fall-arrest harness systems may influence the decision whether or not to use a fall-arrest harness.

These factors generally confirm findings by other researchers of work related falls associated with use or non-use of a harness system. However, one factor which has not figured prominently in previous reports is the workers' concern about the effects of being suspended after a fall has been arrested by a fall-arrest harness system. On ten occasions the interviewees made reference to an expectation that being suspended in a fall-arrest

harness would be highly uncomfortable. Time periods of 7 minutes and 16 minutes were reportedly necessary to achieve the retrieval of a suspended worker. Only one interviewee had actually experienced a trial of being suspended in a fall-arrest harness (for approximately two minutes) and he described it as a very bad sensation. These concerns may be well founded.

The "Industrial fall-arrest system and devices" Standard (AS/NZS 1891.4:2000) warns of the possibility of the onset of suspension trauma while a person is carrying out a trial suspension in a fall-arrest harness to check for comfort. The Standard warns of "serious consequences" if a person is suspended for more than a "short period". Appendix A of the standard, AS/NZS 1891.4:2000, provides the following information:

*Suspension trauma is a condition (e.g. following a fall), whereby a person suspended in a harness in a substantially upright position may experience blood pooling in the legs. Depending on the susceptibility of the individual, this may lead to loss of consciousness, renal failure and eventual death.*

*In clinical trials, although some subjects experienced no effects after prolonged suspension, others experienced fainting or loss of consciousness in just a few minutes. The initial indications are that a person's susceptibility may be unrelated to fitness level or any other obvious physical condition or attributes.*

A research report (Seddon 2002, p. 21) which reviewed and evaluated existing information about suspension trauma stated that its existence had been established beyond all doubt. The medical term for the condition is alternatively *orthostatic syndrome* or *orthostatic shock*. That report discusses in detail the physiological changes and damage that can occur to a person while suspended in a harness. Venous pooling in the legs, resulting from being immobile for a period of time in a mainly vertical position with the legs below the heart, is thought to be the main cause of a reduction of the blood supply to the heart and a subsequent potentially fatal reduced blood flow to the brain (Seddon 2002, p. 2). Suspension trauma may be exacerbated by pain, shock and any injury that may have occurred before or during a fall. *It is also said that leaving an unconscious person suspended on a rope can cause death in less than 10 minutes* (p. 39). The retrieval speed, rescue technique, and treatment of the person immediately after rescue, are critical. Incorrect treatment of a person post-rescue could exacerbate suspension trauma. The report includes an illustrative description of how orthostatic shock may occur (Seddon 2002, p. 29), a copy of which appears in Figure 1.

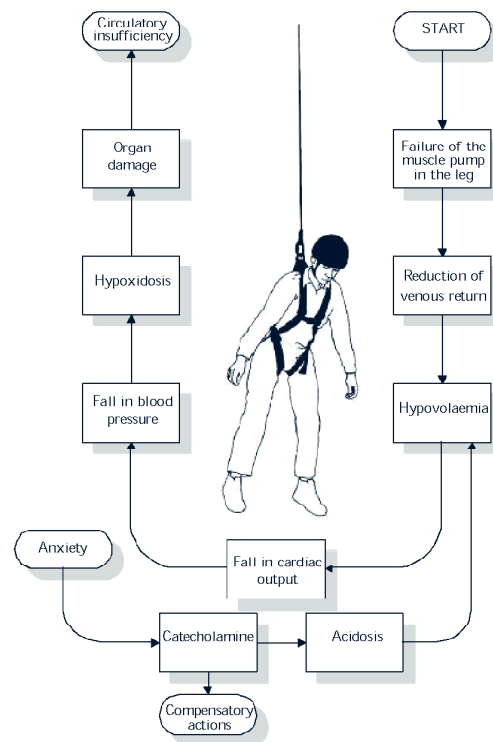


Figure 1. "Probable order of processes leading to death from protracted orthostatic shock" (Source: Seddon, P. (2002, p. 29). *Harness suspension: review and evaluation of existing information*. [Online], Available: [http://www.hse.gov.uk/research/crr\\_pdf/2002/crr02451.pdf](http://www.hse.gov.uk/research/crr_pdf/2002/crr02451.pdf))

It seems likely that the fall-arrest harnesses currently in use may not be satisfactory and may not prevent a fatality in the event of a fall where rescue of the suspended person is not carried out in a very short period of time. Comments made by interviewees suggest that workers may not be adequately trained and prepared to carry out a rescue in the shortest possible time. If fall-arrest harness systems are to be used as safety equipment for protection against falls, the harness must be of a design which allows prolonged suspension without discomfort. Issues relating to the use of arresting devices and anchorage also need to be addressed so that workers will be less likely to fail to attach their harness to an anchorage system.



Recommendations for further research:

1. Investigation of suspension trauma and the effects of harness design on the onset of suspension trauma.
2. Investigation of lanyards/arresting devices to identify possible improvements.
3. Investigate training issues, and workplace rescue procedures.

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## Forum

[Ed: The first two items were prepared in response to a request from the President, Margaret Head, asking Board members to write an item about a possible name change for the ESA, to be included in "Forum" to encourage membership participation in the discussion following previous comment in "Forum" by Verna Blewett and Max Hely.]

### (1) DAVID CAPLE RESPONDED:

My opinion is influenced by three issues:-

#### Technical Considerations

For those with a long memory in ergonomics, the use of the terminology ergonomics and human factors or human factors engineering have been rather interchangeable. The European /UK founders chose the term ergonomics. They tended to be from an engineering / physiology background to the multi-disciplined science. The USA founders chose Human Factors. They mainly came from the psychology / physiology background. In reality they were all studying the same population of issue and actively interchanged methodologies and research findings.

Hence, from a technical perspective, a change to "Ergonomics and Human Factors" is a bit like saying "Water and H<sub>2</sub>O" – they mean the same thing.

#### Internal Perspective

Over time, the perception of ergonomics in Australia has gravitated towards the physiology / OH & S application of the science. In contrast, Human Factors has grown, particularly with HCI, towards psychological applications of the science.

The timing of this debate is mainly around the genuine and admirable objective of reconnecting the different interest areas back under one umbrella.

Whilst I have been a strong advocate for this, I am pragmatic enough to accept that people with like interests connect and want to meet together. This will continue within our broad science regardless of the society's name.

The challenge is not one of semantics but one of internal management of the Society to ensure that we cater for all interest areas of our broad membership base.

#### External Perspective

In the USA, the "Human Factors and Ergonomics Society" was introduced to replace the "Human Factors Society" in recent years. It is the only large IEA Society to do so that I am aware of. The very public debate over the "Ergonomics Rule" in the USA strongly linked ergonomics with musculo skeletal injury prevention – and destroyed a lot of credibility of the science in the process.