



# ***PROFESSIONALISM and EXCELLENCE for the FUTURE***

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# Millennials and Safety: The Employment Game

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**Abstract:** The world is painting a new, younger masterpiece as the work culture has changed. Millennials in the workplace is a fact. Currently, Millennials are already the largest segment in the U.S. workforce. Within the next two to three years, fifty percent of the U.S. workforce is expected to be made up of Millennials; it will be seventy-five percent by 2030, according to the U.S. Bureau of Labor Statistics (October 9, 2018). Attracting, training, and retaining Millennials in the workforce is not difficult, so it appears on social media. In retrospect and in reality, loyalty and longevity are terms of the past. By examining employment, training, and retention tips about our next potential safety professionals and the game plan needed to draw young professionals into and retain them in the safety profession, we become the learners about Millennials. This presentation will attempt to explain the safety stigma of “everyone needs safety, but no one wants to do safety as a job” in the Millennial world.

## Introduction:

Arriving on the heels of Generation X, Millennials Generation Y have experienced a very different upbringing than the perceived instability of the Gen X “latch-key” kids, through a flipside style of parenting which managed every aspect of their lives with planned activities and structure. This is where Gen Y fits into the age group food chain:

- Baby Boomers: Baby boomers were born between 1944 and 1964. They're currently 55–75 years old (76 million in U.S.).
- Gen X: Gen X was born between 1965 and 1979. They're currently 40–54 years old (82 million people in U.S.).
- Gen Y: Gen Y, or Millennials, were born between 1980 and 1994. They are currently 25–39 years old.
  - o Gen Y.1 = 25–29 years old (31 million people in U.S.).
  - o Gen Y.2 = 29–39 (42 million people in U.S.).
- Gen Z: Gen Z is the newest generation and were born between 1995 and 2015. They are currently 4–24 years old (nearly 74 million in U.S.).

The term “Millennial” has become the popular way to reference both segments of Gen Y (more on Y.1 and Y.2). They were encouraged, their self-esteem was defended, and they have never known life without computers and the internet. What makes a millennial care? When you consider the defining moments of lives, events such as the, World Trade Center, Sandy Hook, Oklahoma City bombing, mass shootings at Virginia Tech and Columbine; demonstrating an increasing number of violent acts in the news – it is not surprising Generation Y feels this anxiety keenly. These acts of violence only makes sense, safety and self-preservation is a priority to them. If given a choice, Millennials will appear to choose the less risk route and avoid conflict whenever and wherever possible. It's also important to note, many younger workers are among the first generation of children to have been closely supervised and provided with safety gear for common childhood. Growing up in a world where bicycle helmets are mandatory, inspecting your book bag is not an option, and cell phones are part of their daily accessories, it becomes evident we have made safety a stigma. We tell Millennials safety is a must, yet they observe many in the older generation 35 plus, breaking the same rules they try to instill in them. This creates conflict, risk, controversy, they feel is not necessary or can be obscure in their consequences. The way Millennials perceive life and death is like video games which kill fictitious characters whom always seem to be reset and come back to life to shoot them again. The real world has made them desensitized to “real killings” and mass suicides, so they have a learned behavior, take less risk or die!

In fact, according to the American Psychological Association, Millennials reported, personal safety is a stressor in their daily life and more importantly in their workplace, and they are more concerned about

personal safety than possibly any other preceding generation in the workplace. Some of this concern is warranted, as the Centers for Disease Control and Prevention reports statistics show workers under the age of 24 are more likely to be injured in the workplace. A trend being attributed to less experience and training, as well as the fact many young workers (those aged 15 to 24) are more likely to be working in an environment prone to injury, such as a restaurants, moving companies, or as a laborers. Millennials have made it very clear: employers must expend funds to provide them with a safe work place and less stress, so it is up to Occupational Safety and Health professionals to not only create safer workplaces, but to communicate about workplace safety in a way which resonates with these individuals through games, interactive video television, I-Pods, and remote superiors. The safety commitment, “Company X has to triple safety checks for guns, knives, and bully free attitude safe guards at the company door.

Companies can employ a number of tactics to address this area of real concern, such as:

- Make it clear that workplace safety is a top priority, and tailor the related communications and training to most effectively fit the way Millennials absorb information.
- Make access to all safety and security information transparent and easily reachable.
- Give workers the task of examining and reporting on ways they think workplace safety could be improved, perhaps forming competitive teams and offering rewards.
- Use Infographics to help communicate safety information in an easily-understood way.
- Use temporary assignments involving safety tasks, such as conducting safety audits or completing safety training, to help enhance the company's commitment to safety.
- Review and update safety training and materials annually, or whenever a change in the physical or personnel environment requires a more frequent update.

## Employment

A company should have millennials as employees who are in a position of leadership or have a clear path to becoming a senior leader or manager. It shows millennial consumers the business trust is in their ability to perform and make decisions. Their generation is constantly being talked down upon, so it gives them great satisfaction when people are willing to give them a chance to prove themselves. Although Millennials have a different approach to their work than other generations, they are equally committed and hardworking, if they feel a sense of purpose and a meaningful connection to their team. Millennials are truly very different. What is key for those of us who will employ, work alongside, mentor, or just watch them is the fact we must



understand there are already 76 million American Millennials born between 1979 and 1996 who are ready to be employed or already employed. Barring any other calamitous event or game-changing moment, these First Globals' or GEN Y will soon surpass Baby Boomers in sheer numbers. They will be 35% of America's work force in a year or two and 35% of the electorate in a little over a decade. "Older generations" tend to refer to Millennials as an entitled, technology dependent generation with a "know it all" complex. We worry about our kids growing up addicted to their phones, tablets, and laptops, and our fears are justified. According to CNN.COM, teens spend over 9 hours a day on mobile devices. There are plenty of discussions to have surrounding the long-term effects on the mind and body, but one result of the technology boom cannot be argued; Millennials are more efficient learners. Next time you see a young person engaging in social media or fixated on a video game, remember that is probably exactly what he or she should be doing to prepare for the world of work in the 21st Century and beyond.

Safety has become a buzz word on Social media which is second nature to Millennials. If social media is the medium of choice exploit it! Use the platform to discuss a safety program and engage workers in the safety conversation. Conduct polls, share photos and stories on Facebook which demonstrates a commitment to safety, and encourage participation in the conversation. Make up scenarios where Millennials have to solve the safety hazard to ensure they and all co-workers are risk/hazard free. Give points for the fastest resolution and always praise for doing a good job! Not only do you engage your current employees, but discussing safety on social media can also help attract new employees to the company and aptitude testing for safety minded Millennials should be the norm rather than the exception. Hiring a Millennial who thinks like this must be educated, trained, and almost have a marketing minor to be able to demonstrate the capability to engage and keep Millennials engaged in the safety profession. Does this sound like a casino arcade, minus the smoke and mirrors? Millennials will only interact with those who understand their values. Among these values are: connections, experiences, purpose, encouragement, and innovation. Any company seeking to hire and retain Millennials has to communicate its understanding of these values and illustrate the company considers them to be very important within its culture or Millennials will not remain in their culture.

Getting Millennials' attention to even examine safety as a job requires a barrage of streaming, texting, Facebook, Twitter, and multiple combinations of live interactive communications media. Never has a generation been controlled by media communications since the 1930's and 40's like the Gen Y Millennials. The Great Depression, and World War II touched massive regions and many Continents of the World by newspaper, radio, and pamphlets. Orators brainwashed entire nations, ushered them into war and changed the face of history. The lack of currency value drove the quality of life to an all-time low and touched each and every individual on many continents with direct negative physical and mental impacts. Many chose suicide, crime, or other means of dealing with the harsh times. Generation Y seems to be somewhat benevolent about depression and life sustainment. Their generation is the, "I am entitled to it," whatever it is they are entitled to. They are not afraid to work for what they want or need, but work only to get what they want. In other words overtime is out unless it is an absolute necessity.

It's hard to put into perspective, but take the invention of the hamburger. McDonalds is now on every Continent; however, not everyone has eaten a Big Mac, but nearly everyone has heard of one. All Continents have computers, but how many Continents don't have cell phones or other mass communications media, all do is the correct answer! A communications culture change as well as a safety culture change has brought the work place into a new Millennium. Millennials love their phones and their phones are constantly in their hands, as if it were a permanent attachment. They check their phones immediately when they wake up, the phone is given more attention than actual

people such as at the dinner table, and their phone stores almost all of their entertainment, social life, and personal information. Their cell is a very important asset for them. When you take their cell away at work they become nervous, suspicious, and ambivalent towards work. It is in any company's best interest to take advantage of millennials fascination with their phones. Texting is the preferred form of communication for millennials – entire conversations can be had through text messaging. Any business thinking of hiring a Millennial should be using text marketing to communicate with them. They will be more receptive to this form of communication and choose to engage with it. It would be a wiser investment to place your money in a marketing activity which will actually provide a positive Return-On-Investment for your business, thus converting your target Millennial market into safety team-mates. Millennials like to feel as if they are partaking in something special – something giving them an actual purpose. Just offering safety as an alternative or service to them without a distinctive message will not work in any businesses favor. Millennials don't like being sold to, instead they like engaging within a movement which feels authentic and fun.

To get ahead in the safety business, the employer must develop an interactive community of Millennial consumers who want to work in the safety profession, by following good safety practices with rewards. Give them something distinctive to do, such as working within their restricted bounds. Have them do something different every month, such as a new challenge to complete tasks being scored against others in the community. The fun and engaging factor of a safety professional business will provide it with more attention, pulling in other millennials who want to be an active members of a growing safety culture or growing community which sets them in high gear and promotes a conducive and interactive workplace. How do you make Safety fun? Millennials understand life is serious, but that doesn't mean they want to be so serious they can't have fun. Being too serious stifles their creativity and freedom, two things they absolutely need to function well. First, once their positive vibe is smothered, they tune out and become less productive. Secondly, they become bored very easily, employers must give them something incorporating using their hand and eye coordination. Millennials show Safety is all about having fun and enjoyment while getting the job done safely. Add humor into safety messages and illustrate your concern for your workers to be safe and enjoy life is the message. Millennials don't make business strictly business, business has to make people feel excited to be a part of it. Demonstrating the value of Safety is hard to quantify, showing Millennials they are a valuable resource to the workplace will in-turn focus their energy into realism and productivity. There are at least one out of three workers now in the Millennium age range or more entering the workplace on a daily basis. Information is power to each and every one of them. Give them the tools they need to get information, a task and watch them go.

Millennials have unprecedented access to seemingly infinite information at their fingertips. Where older generations had to drive to the library and thumb through books to find one answer, Millennials have 10 answers in the time it took previous gens' to buckle their seat belts. Their attention span is so short because it can be. The days of hunting for information have passed, and generations to come are no longer going to sit for 8 hours in order to obtain information, Millennials can find in 8 seconds. With keen trained eyes and lightning speed computer key strokes, Millennials are more focused on how to extract the maximum data out of software and hardware than first gen computer programmers ever imagined. They are equally quick at solving problems be it physical or mental challenges and can tell you very quickly if a regulation is pertinent to the situation or not. Arguing with a Millennial is a moot point. If the data shows they are correct, they make their point and become silent. Given this approach, safety would be a self-governed and individual enforced activity. Millennials see safety as the requirement to protect themselves as the Police are everywhere to stop in-despicable acts from occurring. In a perfect millennial world everyone would obey all safety regulations

and no one would take short cuts or deviate from procedures or processes. A good Safety Professional knows how to enforce without force and train workers without pushing a button.

### Training

Millennials will accept the reality of being safe and making decisions key stakeholders and risk takers can quantify. The approach of briefing on line or through video teleconferencing is giving way to open up a new type of safety work environment – VideoSafing. By making safety training a game, points scored can add up to valued rewards, thus giving on the spot gratification for performing acts safely. This virtual positive reinforcement will fit into the Millennial's change process. Millennials and later generations were born into a digital world. (These days, by the time the average American has turned 21, they've spent 6,000 to 9,000 hours playing video games, but only about 2,000 hours reading books). They've been fed on video games, and it means they learn and play differently from older generations. Millennials are totally comfortable with technology, and research has shown they crave variety in media and are born multitaskers, so they cannot just sit and listen to a talking head, the way earlier generations used to.

Intuitively, it makes sense for training programs to use games, since Millennial brains are already wired as such. The "gamification of training" means using game design techniques in a non-game situation to engage users and reinforce a specific skill or concept. Training games use techniques from the game world like rewards, points, badges, frequent feedback, progression through many levels, etc. to make training more effective by making learning more fun. Basically, it's all about engagement and Inclusion when it comes to training Millennials. Active learning approaches, where the student has to interact with the material being taught, are associated with greater academic achievement. This has been studied a lot in the medical world, where one study found learners in an engaged classroom had better knowledge retention than non-engaged students. The same study found a percentage of game style high-fidelity simulation also greatly improved students' knowledge retention.

Gamified training can also change habits, through repeated retrieval and spaced retrieval. Retrieval practice forces learners to recall information, rather than just listen to it or read it. On its own, retrieval practice can improve recall performance by 10% to 20%. Spaced retrieval is providing the learner with quizzes or course content spaced over time, and when combined with retrieval practice it multiplies the effect and improves recall performance by as much as 35% to 60%. Gamification also generates intrinsic motivation in users through challenge, curiosity, competition, and other natural human motivation factors. For example, in jobs where output is easily measured, training games can be used as competitive features like company-wide leader boards to inspire either competition or teamwork. Anything offering a boost to employee engagement is good for business—a 2012 Gallup study found companies with an engaged workforce outperformed their non-engaged competition by 147%. This is called, you have a winner! A recent study of over 6,000 employees in the US and Canada found being allowed to play a casual game for a few minutes before participating in training was a motivational hook which improved engagement. Employees logged into training often were more apt to finish their modules (so they were more likely to complete their training). Perhaps more surprising was the study found it put them in a mental zone where they could actually focus better, boosting their learning outcomes and improving recall of the training data.

### Retention

Millennials are not totally bias to the workplace as it stands today, however, Millennials do believe by building a workplace they thrive in doesn't mean getting rid of everything previous generations have worked for. As you can see from the extensive collection of Millennium data compiled at the end of this paper, they're very traditional in some senses - they want good compensation, fair benefits and good friends in the office, the chance to grow and develop, and a few corpo-

rate perks thrown-in to sweeten the deal. Their unique circumstances and backgrounds have led them to approach companies with a different perspective. For example, being raised in a layoff culture has led them to view loyalty in terms of months, not years. Also, their mobile technology-centric lifestyles have made them view the traditional, 9-5, cubicle-dwelling work arrangement as outdated. Conversely, they do not want work demands interfering with their personal lives, and unlike previous generations who acquiesced to the 'rat race' norm, they are even willing to accept reduced compensation and relinquish opportunities for promotion if it permits them to work fewer hours. As with our other statistics pages (employee engagement and loyalty, 2016 edition), each stat below has links to the original sources. This data is compiled on behalf of Access Perks, provider of America's best employee discount programs. So, what can companies do to address the specific needs of Millennial workers in an effort to retain them longer?

- Give them respect, attention and encouragement, and feedback which includes both praise and constructive critique.
- Adopt a leadership style emphasizing openness to questioning management, clearly defined expectations, and guiding vs. controlling the team.
- Recognize them as both unique individuals and valuable members of the team. Allow them to work independently on projects, but provide frequent feedback (monthly or even more often).
- Show concern for their personal lives, and accommodate the work/life balance they seek by organizing social activities at work, agreeing to alternative arrangements regarding when and where they work, and even offering an option to decrease their hours or take a sabbatical through a reduction in pay.
- Recognize the fact they tend to measure productivity in terms of work completed rather than number of hours worked and consider adjusting policies accordingly.
- Provide opportunities for development, and strive to make full use of each worker's skillset. A Deloitte study this year revealed only 28% of Millennials believe employers are making full use of their abilities, and they aspire to apply all their talents to their work.
- Understand how greatly the philosophy of startup culture has shaped what Millennials consider an ideal workplace, and employ as many key elements to your workplace model as possible: transparency, a less-traditional hierarchy, frequent opportunities for advancement based on ability, tolerance for diversity and open access to management.
- Demonstrate the company operates ethically, showing a greater concern for employees and society than the bottom line.
- Offer competitive benefits, which may include both traditional (health insurance, paid time off) and non-traditional (flex time, sabbaticals, gym memberships, training allowances, etc.) benefits.
- Use mentoring and coaching designed to keep multi-tasking Millennials engaged, teach them new skills, and recognize their achievements.
- Encourage their own leadership through reverse mentoring which enables Millennials to share their knowledge of technology or their unique approach to finding solutions, and involve them in intergenerational teams which benefit everyone.

Experiences are what Millennials crave, so safety businesses must work to involve them within the company's vision and mission in order to retain their employment.

### Conclusion:

The Millennial voting bloc has already helped make some progress on changing the safety culture. Throughout the 2000s, when voting millennials were coming of age, OSHA and similar organizations made several significant improvements to workplace safety laws and expectations. This is not to say Millennials took to the polls to vote for Hope, Change and better Workers' Compensation, but the truth is,

Millennials are helping shift our cultural, social and professional priorities in a major way. Every word of support they voice for progressive, worker-friendly politicians and bureaucrats helped deliver these wins. Here's a sampling of what has won favor with the Millennials:

- 1970s: Before millennials hit the polls, a series of high-intensity political debates saw the introduction of the Job Safety Law of 1970, the rollout of factory safety laws, the development of Workers' Compensation and the rise of Federal influence in workplace safety in general. Each of these developments helped pave the way for more breakthroughs in workplace safety.
- 2005: A BP oil refinery explosion in Texas kills 15 and injures 160. OSHA levies the largest fines in its history and develops stricter refinery inspection paradigms.
- 2007: OSHA passes a new rule requiring employers to provide personal protective equipment (PPE) in workplaces where safety is a daily challenge, rather than forcing their employees to purchase it themselves.
- 2010: OSHA commits to helping employers find and reduce safety hazards in the workplace by developing a voluntary program to help them establish new ways of doing things.

But don't think for a moment you have to wait on the federal or even state governments to tell you how to be safer at work. The truth is, every worker helps bear the responsibility every day. So if millennials are helping carry the standard of safety into a new era, it falls on employers and business leaders to help them do it. Here are some ideas to attaining a safety minded goal:

- **Put Safety First** – It doesn't matter if you operate a factory or a set of cubicles — safety should be a priority everywhere. Let your team know what you're doing to keep them safe and make sure you're communicating your safety expectations to each new hire. Take nothing for granted. Even if you're not in a fire-prone line of work, for example, you should have safeguards in place as a precaution. Have Millennials be major participants.
- **Take security precautions:** Nobody expects burglaries or unauthorized access to happen, however, precautions are a logical step to take. Consider investing in basic security, like controlled entry using RFID chips in employee badges. A basic security risk assessment by a professional security company could help you identify potential problems before they happen and deliver a solution your staff will appreciate and Millennials will feel secure in the environment.
- **If your workplace has specific safety concerns, retrain staff:** Some workplaces employing heavy machinery follow formal regulations and standards for retraining authorized personnel on its operation. For everything else, insist on refreshing your workers' knowledge of their work safety — and the machines they use to perform it — on a quarterly or annual basis. Have Millennials participate in the safety training as a liaison venue.

Doing things like this will enhance a company's chance of attracting, hiring and retaining Millennials. Safety Professionals will be needed at all levels of the workplace.

While Millennials are vastly different from previous generations, they are not impossible to reach and engage with. Take the time to understand how they communicate and what motivates their behaviors and actions. Once you truly understand how to communicate with them, the easier it will be for you to convert them into your customers, employees, and co-workers. The point is, safety is an opportunity — not a burden. Millennials who have been properly safety trained and are taking it seriously, means communicating with their team members, ensuring you value their time and well-being, not to mention securing yourself from a loss of life, property and even your entire business. By taking sensible precautions and listening to the priorities of America's younger working generations, we can all breathe a little easier at work.

## DATA:

### Millennial Employee Engagement and Loyalty Stats

- 46% of 18-to-25-year-olds is the age group most likely to leave their job (Ajilon)
- 38% of younger employees ages 18-25 and 34% of employees ages 51-55 were most likely to quit their job because of a co-worker (Comparably)
- 36% of workers and nearly half of millennials would consider quitting a job not providing for learning opportunities (Docebo)
- Nearly a third of millennials say they'll be chasing higher salaries at another employer five years from now (Staples)
- About 40% of millennials have taken one job over another because of a company's sustainability (Swytch)
- 70% of millennials said a company's sustainability would impact their decision to stay with a company for the long haul (Swytch)
- 90% of Millennials want to grow their careers with their current companies (Bridge)
- 59% of employees say they've been with their current employer for more than 3 years and among older millennials (ages 30-37), 22% have been with their current employer for more than 7 years (Udemy)
- 74% of millennials believe job hunting could help their careers (Robert Half)
- 40% of millennials say they are "somewhat" committed to their employer (ReportLinker)
- 29% of millennials are engaged at work, 16% are actively disengaged, 55% are not engaged (Gallup)
- Millennials and Gen Z are twice as likely as Baby Boomers and Gen X to disengage at work (RingCentral Glip)
- Almost two-thirds of workers ages 18-34 said they're motivated by video meetings and team messaging (RingCentral Glip)
- 54% of those younger than 35 say it's a good time to find a quality job versus 48% of those aged 35 and older (Gallup)
- 21% of millennials say they've changed jobs within the past year, more than 3x the number of non-millennials (Gallup)
- Millennial turnover costs the U.S. economy \$30.5 billion annually (Gallup)
- 44% of Millennials say, if given the choice, they expect to leave their current employers in the next two years (Deloitte)
- 48% of millennials said they will look for a new job in the next three months, and 56% begin their search in the next year (Spherion)
- 87% of U.S. workers ages 18-34, 70% ages 35-54, and 44% ages 55+ factor in health and wellness offerings in their job decisions (OfficeTeam)
- 43% of millennials envision leaving their jobs within 2 years, and 28% are looking to stay beyond 5 years (Deloitte)
- 62% of millennials who would willingly leave their employers within the next 2 years regard the gig economy as a viable alternative to full-time employment (Deloitte)
- Employees with 3-6 months on staff were 19% more likely to churn than those with less than 3 months tenure (12%), and workers ages 18-24 were 40% more likely to leave for another job (Culture Amp)
- Almost 25% of millennials have worked for 5 different employers (O.C. Tanner)
- 82% of millennials who work at independent insurance agencies are encouraging their friends and family to also get into the line of work (Vertafore)
- 67% of millennials who work at independent insurance agencies have been in the industry for three years or longer and plan to stay in the industry for as long as possible (Vertafore)
- 32% of workers ages 18-35 say they can see themselves leaving their job within a year (Comparably)

- 24% of workers over 35 say they can see themselves leaving their job within a year vs 32% of millennials (Comparably)
- 19% of millennials and 8% of boomers are looking to exit their company (IBM)
- 28% of workers ages 18-35 say they can see themselves staying on for at least another two years (Comparably)
- 58% of millennials reported they intended to stay in their current role for fewer than three years (Red Brick)
- 52% of millennials viewed the concept of employee loyalty as being overrated (Red Brick)
- 64% of millennials say benefits are extremely or very important to employer loyalty (Qualtrics)
- 62% of Millennials are more likely to say their loyalty to their company is influenced by how much the company cares about their financial well-being as compared to Gen X (50%) and baby boomers (36%) (PwC)
- 72% of millennials and 71% of Gen X are more likely to be attracted to another company who cares more about their financial well-being than baby boomers (45%) (PwC)
- 67% of gig-only millennials reported they like their current work situation and wouldn't want to change it, and 75% of workers over the age of 56 reported the same (Prudential)
- 45% of Gen X gig-only workers reported satisfaction with their work (Prudential)
- 56% of millennials believe an individual should stay at a single company for more than 20 years (Bridge)
- 44% of millennial leaders say they intend to stay at their same company for more than 15 years; 29% of non-millennial leaders said the same thing (The Conference Board)
- 78% of Millennials prefer a stable job (DeVry University)
- 32% of millennials said they are likely to leave their job within the next six months, compared to 11-12% of GenXers and Boomers (Clutch)
- 71% of Millennials are actively seeking a new job, compared to 44% of Baby Boomers (ICIMS)
- 42% of millennials expect to change jobs at least every 1-3 years (Jobvite)
- 50% of Millennials (compared with 60% of non-millennials) strongly agree they plan to be working at their company one year from now (Gallup)
- 76% of Millennial employees expect to change careers – not just jobs – at some point (Cornerstone)
- 93% of millennials left their company the last time they changed roles (Gallup)
- 70% of millennials have considered leaving a job for another boasting flexible work options, but just 50% of older workers have felt the same pull (FlexJobs)
- Almost 80% of millennials said they would be more loyal to an employer offering flexible work options, while just over 70% of older workers said they same (FlexJobs)
- More than 80% of millennials say they seriously consider how a position will affect their work-life balance, but only 62% of older workers agreed (FlexJobs)
- 37% of Gen X contemplate leaving to advance their careers, 5% lower than millennials (DDI)
- If a job lacks growth opportunities and avenues for leadership development, 67% of millennials would leave the position (Bridge)
- Offering career training and development would keep 86% of millennials from leaving their current position (Bridge)
- Workers ages 18-35 rank career advancement opportunities (32%) and work-life balance (34%) as most important to them at work (Comparably)
- 95% of millennial employees report a work/life balance is important to them, with 70% saying it's a very important aspect of

their careers (Deloitte)

- 51% of U.S. workers overall (60% of millennials) are considering new employment opportunities (Gallup)
- 36% of Millennials report they will look for a job with a different organization in the next 12 months if the job market improves, compared with 21% of non-millennials (Gallup)
- Engaged millennials are 64% less likely to say they will switch jobs if the job market improves in the next 12 months (Gallup)
- Millennial managers are nearly two-thirds less likely to resign (11.9%) than non-manager millennials (36.2%) (Visier)
- Millennial managers who haven't been promoted resign at a rate of 5.2% higher than the average, while millennial managers who were promoted in the last two years resign at a rate of 3.1% below average (Visier)
- 22% of millennials job hop within a company nearly twice as often as other generations (12%) (Visier)
- 22% of millennial employees (ages 18-34) would consider taking a job with an organization not having a positive long-term outlook if it meant they'd be advancing their career in the short-term (LinkedIn)
- Millennials are 50% more likely to relocate and 16% more likely to switch industries for a new job than nonmillennials (LinkedIn)
- 76% of Professionals ages 18-34 are more likely to relocate vs. 62% of those ages 35-54 and 40% age 55+ (Robert Half)
- 68% of Millennials say the longest they would stay at a job they like is at least three years (Qualtrics)
- More than 35% of 18-34 year olds ranked compensation as the top motivating factor to leave their job (Ceridian)
- 53% of CFOs say millennials are less loyal to the company (Duke/CFO)
- 25% of Millennials believe staying at a job for seven months indicates they're loyal; Boomers believe the number to be loyal is five years (Ultimate Software)
- Millennials who feel they're at a great workplace are 25 times more likely to plan a long-term future at that workplace (Great Place to Work)
- 62% of millennials who feel they can talk with their manager about non-work-related issues plan to be with their current organization one year from now (Gallup)
- 71% of millennials who strongly agree they know what their organization stands for and what makes it different from its competitors say they plan to be with their company for at least one year (Gallup)
- Those ages 18-34 (26%) and 35-54 (27%) are more likely to cite technology as a concern in overseeing an older employee (OfficeTeam)
- 71% of Millennials say an organization's view of technology will influence whether they want to work there and 66% of Gen Xers and 53% of baby boomers feel similarly (CompTIA)
- 65% of millennials are satisfied in their current jobs (LaSalle)
- One-third of all workers, 50% ages 26-35 and 27% ages 18-25 had quit a job to attend to caregiving responsibilities (The Caring Company)
- Caretaking-related exit rates rose with position ranking: 23% of ages 26-35, 44% of managers of employees, 53% of managers of managers and 61% of senior leaders had quit (The Caring Company)

#### Stats about Millennials and Career Goals

- 55% of Millennials cite leadership opportunities as a key consideration (Impraise)
- 45% of millennials are pleased with their career path, and 49% with training and development programs at their company (LaSalle)
- 72% of workers ages 18-34 said they'll take a new title without a



- pay hike, compared to 61% of workers ages 35-54 and 53% of those 55+ (OfficeTeam)
- 45% of Gen Z and millennials want to work in technology (45%), the next highest choice was education (17%) (Future Workplace)
- 45% of Millennials would quit a job if they didn't see a career path they wanted at the company (Ultimate Software)
- 63% of Millennials look for jobs at learning organizations where they will have access to training, workshops, and company-funded postgraduate schooling (Impraise)
- 58% of employees (62% of Millennials and GenX) say professional development contributes to their job satisfaction (CompTIA)
- 87% of millennials say professional development or career growth opportunities are very important (Gallup)
- 12% of employees feel their employers aid them in their career development (Bridge)
- 62% of executives say Millennials will consider leaving their jobs due to lack of learning and development, just 31% of Millennials say they have considered this (Oxford Economics)
- 58% of Generation Zers said they would come into work on evenings and weekends in exchange for a bigger paycheck, compared with 45% of millennials, 40% of Gen X, and 33% of boomers (Monster)
- Young Millennials age 18-24 (25.1%) and older Millennials age 25-34 (29.2%) are more than twice as likely to get company emails on their mobile device compared to Baby Boomers age 65+ (12.2%) (Samanage)
- 38% of millennials ages 18-35 say they plan to start their own company in the next five years (Comparably)
- 54% of millennials would quit their job and start a business in the next six months if they had the tools and resources needed, compared to 41% of all adults (America's Small Business Development Centers)
- 61% of millennials say there is more job security in owning their own business than in working for someone else; 64% of boomers think there is greater job security in working for someone else than in owning their own business (America's Small Business Development Centers)
- 51% of recent grads feel like they're underemployed (Accenture)
- 71% of Millennials expecting to leave their employer in the next two years are unhappy with how their leadership skills are being developed (Deloitte)
- 50% of millennials, 40% of Gen X and 35% of boomers say burnout is motivating them to consider changing jobs (Staples)
- 86% of all workers, 39% ages 18-34, 54% ages 45-55 and 50% ages 65+ believe burnout is connected to job satisfaction (University of Phoenix)

#### **Stats About What Millennials Want in Employers and Workplaces**

- 67% of millennials say they are "somewhat happy" at work (Teem)
- 40% of Millennials have high job satisfaction (Deloitte)
- 58% of Millennials want to work for a small or medium sized company compared to 63% of Gen X and 71% of Baby Boomers. Only 13% want to work at very large or global companies with 10,000 or more employees (Future Workplace)
- 52% of millennials say opportunities for career progression is the most desirable quality in a workplace, competitive wages and financial incentives (44%), good training and development programs (35%) (PWC)
- Workers ages 18-34 said career development matters most in accepting a job offer, while workers 55+ cited paid time off as their top factor (Accountemps)
- 76% of millennials think professional development opportunities are one of the most important elements of company culture (Execu-Search)

- 59% of millennials say opportunities to learn and grow are extremely important to them when applying for a job (Gallup)
- 80% of 2016 grads expect their first employer to provide formal training (Accenture)
- 40% of employees age 24 and younger said they'd talk to their boss about making a career change if they had access to additional opportunities to learn and grow within the workplace (LinkedIn)
- 92% of workers ages 25-34 agreed they preferred an older boss (Randstad)
- Traits Millennials look for in employers: Treat employees fairly (73.1%), corporate social responsibility (46.6%), brand image (39.5%), prestige (30.5%) (NSHSS)
- Work atmosphere traits Millennials seek in employers: work/life balance (69.2%), friendly coworkers (57.3%), friendly to people of all backgrounds (55.3%) (NSHSS)
- Millennials and Gen Z working for employers perceived to have diverse workforces and senior management teams are more likely to want to stay 5 or more years (Deloitte)
- Nearly 20% of 24-35 year olds said reputation for ethical behavior, diversity and inclusion as well as workplace wellbeing were important when choosing an employer (Deloitte)
- Roughly 25% of Gen Z, 18% of Millennials, 16% of Gen X and 12% of Boomers are dissatisfied with their work-life balance (Stanford University)
- 57% of Millennials say work-life balance and well-being in a job are "very important" to them (Gallup)
- 46% of millennial fathers feel resentful about their employer's approach to work-life balance (Working Families)
- 41% of millennial workers intend to downshift into a less stressful job to gain a better fit between work and family life (Working Families and Bright Horizons)
- 36% of millennial workers plan to take a pay cut to work fewer hours (Working Families and Bright Horizons)
- When asked what their top priority would be if they became boss, 27% of Gen Z said they would increase employee pay while 35% of Gen Z and 32% of Millennials said they were likely share pay information with coworkers (Comparably)
- 34% of workers feel resentful towards their employer with regards to work-life balance; this increases to 46% for male millennial workers (Working Families and Bright Horizons)
- 65% of millennials said "they did not make enough money to cover expenses or are living paycheck to paycheck" (Ernst & Young)
- 10% of Gen Z and 9% of Millennials say stress accumulated during work hours affects their personal life to a great extent (Stanford University)
- 64% of Millennials and Gen Z employees feel stressed all or most of the time at work (Udemy)
- 67% of Millennials said their financial stress hinders their focus and productivity at work, compared to 32% of Baby Boomers (Bank of America)
- 87% of millennials rate "professional or career growth and development opportunities" as important to them in a job; 69% of non-millennials agree (Gallup)
- 46% of Millennials have asked for a raise in the last two years (Bank of America)
- 80% of Millennials who asked for a raise got one (Bank of America)
- 50% of millennials say they would consider taking a job with a different company for a raise of 20% or less (Gallup)
- 90% of millennials would choose to stay in a job for the next 10 years if they knew they'd get annual raises and upward career mobility (Qualtrics)
- Engaged Millennials are 26% less likely than millennials who

- aren't engaged to say they would consider taking a job with a different company for a raise of 20% or less (Gallup)
- 61% of Millennials say they would switch to a company with no performance reviews (Adobe)
- Among workers ages 18 to 35, 75% expect employers to take a stand on equal rights, climate change, immigration and constitutional rights (Glassdoor)
- 67% of 33 to 44 year olds and 49% of those 45 and older favor employer involvement (Glassdoor)
- 48% of millennials believe businesses behave ethically compared with 65% in 2017 (Deloitte)
- 45% of millennials believe business has a positive impact on society, down from 72% in 2017 (Deloitte)
- 47% of millennials believe business leaders should be committed to helping improve society compared with 62% in 2017 (Deloitte)
- 44% of millennials believe business leaders are making a positive impact and still have some faith in business' ability to enact meaningful change in society (Deloitte)
- 88% of millennials found their job more fulfilling when they were provided opportunities to make a positive impact on social and environmental issues (Cone Communications)
- 75% of millennials believe multinational corporations have the potential to help solve society's economic, environmental and social challenges (Deloitte)
- 44% of Millennials say they would be more loyal to their organization if their CEO took a public position on a hotly debated issue; 19% say they would be less loyal if their CEO spoke out (Weber Shandwick)
- 35% of workers say an eco-friendly workplace is important to consider when looking at a new job, compared to over 50% of Millennials (Staples)
- 81% of millennials expect companies to publicly pledge to be good corporate citizens (Horizon Media)
- 20% of Millennial women "strongly agree" that women are less likely to be considered for senior-level roles in a business/corporate setting than their male counterparts (Nielsen)
- 23% of men and women ages 18-35 say they feel their gender has held them back in their careers (Comparably)
- 35% of Millennials say strong leadership defines a good work culture (Staples)
- 28% of Millennials say feeling appreciated contributes to their loyalty (Staples)
- 26% of Millennials say recognition motivates them to do their best at work (Staples)
- Among millennials who worked at 5-7 organizations, 34% didn't trust their direct manager, 31% said their organizations don't set goals, and 48% said their organization thought only about profits (O.C. Tanner)
- 65% of workers ages 18-24 say they prefer working in a traditional office environment (Randstad)
- 42% of Millennials want feedback every week. This is over twice the percentage of every other generation (Ultimate Software)
- 19% of Millennials say they receive routine feedback from managers (Gallup)
- 31% of Boomers felt they needed less feedback than millennials or Gen X (Korn Ferry)
- 17% of Millennials say the feedback they receive from managers is meaningful (Gallup)
- 54% of Gen Z say the people they work with is the attribute which matters most in order to do their best work (Future Workplace)
- 58% of Generation Zers said they would come into work on evenings and weekends in exchange for a bigger paycheck, compared with 45% of millennials, 40% of Gen X, and 33% of boomers

(Monster)

- 34% of Millennials would quit a job on the spot if their employer asked them to delete their Facebook page (Ultimate Software)
- 40% of Millennials who plan to remain in their jobs beyond 2020 say their employers have a strong sense of purpose beyond financial success (Deloitte)
- 21% of Millennials define a good work environment as a place offering incentives and perks (Staples)
- 46% of Millennials say more office perks would improve their happiness (Staples)
- 40% of millennials see automation as a threat to their jobs (Deloitte)
- 53% of Millennials see their workplace becoming less human as a result of automation (Deloitte)
- Millennials are far more likely to continue employment at a company who implements pet-friendly policies (60%) than their elders (39%) (Banfield)
- 75% of Gen Z college grads are more likely to work for a company which t offers opportunities to work abroad (Graebel)
- Less than 40% of millennials and 30% of Gen Z workers feel they have the skills they'll need to succeed, and they're looking to businesses to help ready them to succeed in this new era (Deloitte)
- 36% of millennials and 42% of Gen Z reported their employers were helping them understand and prepare for the changes with Industry 4.0 (Deloitte)

#### Stats About Millennials and Employee Benefits

- 35% of millennials have turned down job offers because they were dissatisfied with the benefits, compared to 27% of all other age categories (Anthem)
- 62% of millennials are generally satisfied with their benefits, and 63% with their company culture (LaSalle)
- Gen Xers are slightly more satisfied with their benefits than millennials (53% vs 52%), and 49% of boomers report they are satisfied with their benefits (LIMRA)
- 77% of Millennials would be willing to take a salary cut in exchange for long-term job security (Qualtrics)
- 52% of workers ages 55 and older think they are compensated fairly, 44% ages 18-34 and 51% ages 35-54 feel the same (Robert Half)
- 48% of younger millennials (ages 26 to 30) said they felt they were fairly paid, compared with 50% of older millennials (ages 31-35) and 54% of Gen Z (ages 18-25) (Comparably)
- 90% of millennials would choose to stay in a job for the next 10 years if they knew they'd get annual raises and upward career mobility (Qualtrics)
- 44% of millennials (18-34) name health insurance as the most important benefit they receive (Clutch)
- Gen Xers and Boomers focus more on disability insurance (50% and 63%) vs their younger coworkers (33%) (LIMRA)
- 60% of current undergrads expect jobs to start at \$60,000 annually; 10% expect starting salaries of \$100,000 a year (Yello)
- 64% of millennials care more about perks and benefits, compared to 51% of baby boomers and 54% of Gen X (LinkedIn)
- 64% of millennials care more about perks and benefits, compared to 51% of baby boomers and 54% of Gen X (LinkedIn)
- 58% of all workers and 64% of millennials want paid family leave from their employers, ranking at the top of in demand perks like flexible and remote work options (55%), sabbaticals (38%), student loan repayment assistance (35%), pet-friendly workplaces (15%) and pet insurance (15%) (Unum)
- 75% of U.S. millennial workers said the work environment should be flexible and fluid (American Express)
- 94% of Millennials, 92% of Gen X say nontraditional benefits

- make employers more attractive (ICIMS)
- 57% of small businesses offer different benefit packages or perks to attract young talent (Vistage)
- 15% of Gen Z and 19% of Millennials say health care is the most important employee benefit (Future Workplace)
- 67% of millennials, 62% of gen x and 61% of baby boomers believe their employer's benefit plans are competitive with those offered by other organizations (PwC)
- 70% of millennials, 71% of gen x and 75% of baby boomers say they review their benefit elections every year and make changes if needed (PwC)
- 50% of millennials are confident they have a strong understanding of their benefits (Qualtrics)

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# Plant Cultivation in a Desert Climate: Toxic Plants, Toxic Environment

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**Abstract:** "We all know that gardening in the desert is quite a challenge! Besides the heat, low rainfall and poor soil, we have spiny and toxic plants, as well as harmful fungi and hazardous minerals in the soil. Gail Brandys, a Master Gardener and Safety Professional, will review some of the physical, chemical and biological hazards that are most common for gardeners in desert climates and provide helpful hints on how to protect yourself, your family and your pets."

We all know that gardening in the desert is quite a challenge! Besides the heat, low rainfall and poor soil, we have spiny and toxic plants, as well as harmful fungi and hazardous minerals in the soil. This presentation will review some of the physical, chemical and biological hazards that are most common for gardeners in desert climates and provide helpful hints on how to protect yourself, your family and your pets. Our goal is not to dissuade you from gardening . . . but to provide you with useful knowledge to help you garden safely for many years to come.

## TOXINS IN THE GARDEN

Specifically, we will discuss pathogenic organisms, plant toxins and irritants, hazardous chemicals and hazardous materials in the soil including:

- Rose Handler's Disease (Sporotrichosis)
- San Joaquin Valley Fever (Coccidioidomycosis)
- Pet (Cat) Feces Parasite (Toxoplasmosis)
- Oleander Trees (Oleandrin and other toxins)
- Euphorbia / Spurge Sap (eye / skin irritant)
- Sacred Datura (Nightshade poisons)
- Texas Mountain Laurel (Mescal toxins)
- Globe Mallow (Physical eye irritant)

## PATHOGENIC ORGANISMS

Typically, fungi infect plants and bacteria infect animals (humans). But there is some cross over with some "opportunistic" species of fungi and in immuno-compromised individuals such as "senior citizens." (US CDC)

## ROSE HANDLER'S DISEASE (SPOROTRICHOSIS)

Rose Handler's Disease is a rare disease caused by a thermophilic

fungus *Sporothrix schenckii* that is naturally found worldwide on roses, hay, sphagnum moss and pine needles. Being stuck or scraped by a rose thorn can inject the fungus under the skin. A firm pink or purple bump may then form under the skin days or months later (painless or mildly tender.) Treatment is a prescription iodine solution is generally recommended. Untreated, it can become an ulcerated sore and spread. Treatment may take months or years to cure the infection.

Prevention includes covering existing scratches before gardening, wearing leather gloves, long sleeves and sturdy-soled shoes for rose gardening. Avoid steroids since they hamper immune system.

## SAN JOAQUIN VALLEY FEVER (COCCIDIOIDOMYCOSIS)

San Joaquin "Valley Fever" is a rare disease caused by a thermophilic fungus *Coccidioides immitis* that is naturally found in the soil of some areas of California, Arizona, New Mexico, Nevada and Utah. Once inhaled, it produces flu-like symptoms (fever, cough, fatigue, headache, muscle aches, joint pain)

Common exposure scenarios include farmers fields, construction sites and quarries.

Those who are most susceptible are residents over 60 years old, people with chronic illnesses, people who are exposed to airborne dust and dirt and recent "transplants to the Southwest" who have no acquired immunity. (Las Vegas Review Journal reported 72 cases in 2007.) Diagnosis is by sputum or blood test for fungus/antibodies. Treatment can include a prescription antifungal oral medication. DO NOT USE STEROIDS ! Untreated, or improperly treated, it can be fatal (2%) CDC. There is no vaccine for it yet. Individuals should avoid very dusty activities, wear a dust mask (N100) with 2 straps during dusty activities, wet soil down before tilling, and change and wash clothes after dusty work.

### **PET (CAT) FECES PARASITE (TOXOPLASMOSIS)**

Toxoplasmosis is a rare disease caused by a parasite *Toxoplasma gondii* that is found throughout the world and infects some wild and domestic animals. Common exposure routes include :

- 1) Touching feces of cats (or dogs) who had ingested contaminated animals or water
- 2) Gardening in areas where outdoor cats defecate followed by hand to mouth contact (eating or smoking)

(Sources: Haven Animal Hospital Fact Sheet, Las Vegas, NV and Southern Nevada Health District Fact Sheet )

Symptoms include swollen glands, muscle aches. Mild cases can have no symptoms. Can be teratogenic\* in pregnant women. Infection can be diagnosed by a variety of blood tests. Treatment is usually not necessary unless pregnancy is an issue. (The College of Family Physicians of Canada.) Prevention includes keeping cats indoors, not feeding pets raw meat, cleaning the litter box daily (not infective that soon) or use gloves and wash hands afterwards. One should also use gloves when gardening, wash hands after gardening and before eating, wash vegetables and fruit thoroughly after collecting from the garden and washing hands and utensils after touching vegetables and raw meat. ("Preventing congenital toxoplasmosis," Lopez A, Dietz VJ, Wilson M, Navin TR, Jones JL.)

### **OLEANDER TREES (OLEANDRIN AND OTHER TOXINS)**

Oleandrin and other toxins are found in all parts of the oleander tree – dried or green. They are cardiac toxins. Skin contact is most common exposure route.

Ingestion of any part of the oleander plant or inhaling smoke from burning oleander can lead to serious illness and possibly death for humans and animals.

Symptoms of oleander ingestion include skin rash, blurred vision, visual disturbances such as halos, diarrhea, nausea, stomach pain, vomiting, loss of appetite, irregular or slowed heartbeat, weakness, low blood pressure, confusion, dizziness, headache, fainting, depression, drowsiness, or lethargy. (Also drooling in pets.) Severity of symptoms and treatment depends on route of entry and may require hospitalization. Consult an MD or Poison Control Center.

### **Poison Control Centers**

- In the US for People: (800) 222-1222)
- In the US for Animals: ASPCA Animal Poison Control Center (888) 426-4435
- (aspc.org/poisonous plants)

Prevention includes wearing gloves and long sleeves when handling, pruning or cleaning up leaves and branches, washing gloves and tools after use, keeping animals and children away from trees and their debris. Also do not burn the branches or leaves. Composting of oleander tree debris is questionable. Replace oleanders with less toxic plants in the landscape.

### **EUPHORBIA / SPURGE SAP (EYE / SKIN IRRITANT)**

All succulent Euphorbiaceae contain a poisonous sap which exudes from the tiniest injuries, while trimming off live or spent leaves or sometimes even when only touching the plant. Typically this sap is milky white and sets into a latex.

In some species the poison is only mild, but in others it is extremely dangerous. The reason for this are the irritants contained in the sap especially a multitude of Diterpenes and Triterpenes. On mucous membranes and in the eyes even the smallest splashes can cause long-lasting, severe pain. Vapors from sap may also cause eye irritation. Sap can also cause skin irritation on prolonged contact. Several of the components can promote tumors. (CO State U: Veterinary Teaching Hospital Fact Sheet)

Treatment depends on the area affected and severity of symptoms. For skin irritation, wash off skin immediately. For eye irritation, consult a physician.

Prevention includes wearing rubber gloves and safety goggles when working with Euphorbias and never touching your eyes while working with the plants. Afterwards wash hands very carefully clean all tools and gloves. Whenever possible, trim branches when they are dried to minimize sap exposure.

### **SACRED DATURA (NIGHTSHADE POISONS)**

Common names "Thorn-Apple" (due to its spiny seed pod), Jimson Weed and Locoweed. All parts of the plant contain numerous belladonna alkaloids that are toxic to humans and animals and can be fatal if ingested. Toxicity varies widely from plant to plant based on the parameters of its growth environment.

Symptoms of ingestion of the flowers, leaves or seeds occur between one and four hours after ingestion. Symptoms can include dry mouth, thirst, photophobia, blurred vision, confusion, then delirium, visual hallucinations, dilated pupils, agitation, coma, seizures and death (inhibits neurotransmitters.) Keep pets and children away from this plant.

### **TEXAS MOUNTAIN LAUREL (MESCAL TOXINS)**

Botanical name : *Sophora secundiflora* with a common name of Mescal Bean Plant. It has fragrant, purple flowers followed by woody bean pods that house hard red seeds. All parts of the plant are toxic to humans and animals, especially the beans, leaves and flowers if ingested. Symptoms of poisoning typically appear within one hour and include nausea, violent and bloody vomiting, headaches, vertigo, confusion, fever, excessive thirst, cold sweat, respiratory problems. Extreme poisoning includes convulsions and death. Keep pets and children away from this plant.

### **GLOBE MALLOW (PHYSICAL EYE IRRITANT)**

Its other common name is "sore-eye poppy." The plant has fuzzy leaves with star-like hairs called stellates that are very irritating to the eyes. This short-lived perennial typically gets cut back to the ground in winter. Do not rub your eyes after touching the leaves. Wash gloves after touching globe mallow leaves.

### **HAZARDOUS MATERIALS UPDATE**

Round up – Glyphosate  
Naturally-Occurring Asbestos – Actinolite

### **GENERALLY LOW RISK MATERIALS WITH LOTS OF MEDIA HYPE**

#### **ROUND-UP**

Glyphosate is the main ingredient in Round up. Herbicide used to kill weeds and dehydrate crops. Recent law suit in California awarded \$ 289 M to a school groundskeeper who developed non-Hodgkins lymphoma. Cancer was believed to be due in part to his use of Round up on his job for years. IARC has stated that glyphosate is a "probable carcinogen" based on animal studies. Numerous health agencies in the US have stated that there is not sufficient evidence that glyphosate causes cancer.

#### **ABSENCE OF EVIDENCE IS NOT EVIDENCE OF ABSENCE**

What is more troubling is the research done on a variety of oat products marketed in the US. Round-Up is used on mature oat plants to speed up desiccation before harvesting it to use in food meant for human consumption.

("Breakfast With a Dose of Roundup?" Alexis Temkin, PhD, Toxicologist 8/15/18)

**FIFRA: FEDERAL INSECTICIDE, FUNGICIDE and RODENTICIDE ACT**

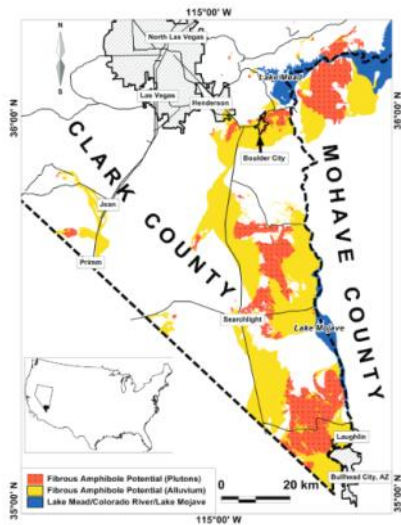
There is a major loop hole in FIFRA! “ Inert Ingredients” are defined as any chemical in the pesticide that is not there to kill the target organism.

Unfortunately, chemicals that are hazardous to humans can be added to pesticides as “inert ingredients.” e.g. benzene. (*Air Quality Study conducted while Spraying for Dutch Elm Disease in IL*)

**NATURALLY-OCCURRING ASBESTOS – ACTINOLITE**

Naturally-Occurring Asbestos (NOA) can be found in many parts of the US including California, Nevada, Arizona, Washington and the eastern seaboard near the Appalachian Mountains. In Southern Nevada it has been found in Boulder City, Henderson and the Lake Mead area. Actinolite Asbestos was found in small quantities in the soil. This is considered to be one of the more harmful mineral types. In an industrial setting asbestos has been known to cause asbestosis, lung cancer, mesothelioma, and recently, ovarian cancer. Diseases are generally related to high-level, long-term exposures.

**NOA – ACTINOLITE LOCATIONS**



“Asbestos found in Nevada and Arizona: Roadblock and potential health hazard?”

Mesothelioma rate slightly above the national average of 1 / 1,000,000.

Industrial hygienists studied the Hoover Dam bypass construction project and took steps to control fugitive dust during the project. Avoidance of very dusty activities in these areas is advisable : dirt biking, road construction, commercial farming, etc. (Wear N100 dust mask) Gardening not believed to be a significant risk.

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**Plant Cultivation Ergonomics: Work Smarter, Not Harder**

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**Abstract:** Working smarter not harder certainly applies to plant cultivation. Whether you are planting, pruning, harvesting or doing maintenance, there may be a better way to accomplish your tasks. Gardening ergonomically isn’t just about the tools you use, rather, it is a system. Ergonomic gardening doesn’t just apply to the elderly or those with physical limitations – it is important for everyone. Come join Master Gardener Gail Brandys, a Certified Safety Professional and President of Occupational and Environmental Health Consulting Services, as she discusses tips, tools and techniques to make small scale plant cultivation more enjoyable while putting less stress on your body. Presentation includes a demonstration of ergonomic gardening tools.

Working smarter not harder certainly applies to plant cultivation. Whether you are planting, pruning, harvesting or doing maintenance, there may be a better way to accomplish your tasks. Gardening ergonomically isn’t just about the tools you use, rather, it is a system. Ergonomic gardening doesn’t just apply to the elderly or those with

physical limitations – it is important for everyone. This presentation will discuss tips, tools and techniques to make small scale plant cultivation more enjoyable while putting less stress on the body.

ERGO = WORK                      NOMIC = STUDY OF



The science that deals with designing and arranging tools and work practices so people can perform work tasks easily, safely and efficiently. The study of how people perform work has been a field of research for over 100 years.

We will discuss how to adapt your work style, tools, yard design and plant selections to minimize stress on the body and make your gardening more efficient and enjoyable! *Work Smarter, not Harder!*

### STRESSORS WE EXPERIENCE WHILE GARDENING:

*Temperature extremes, sunlight, wind, low humidity, pressure on the body, weights to be lifted, awkward positions, friction, irritating chemicals, sharp objects, etc.*

*These make Ergonomic concepts very important*

### WHAT ARE SOME LIMITING PHYSICAL ISSUES OF GARDENING AS WE AGE?

Arthritis, Cardiovascular disease, Diabetes, Medications, Neuromuscular disorders, Thinning skin, Osteoporosis, Respiratory issues, Stress, Stroke, Tendonitis, Old injuries, Loss of balance, Loss of strength, etc.

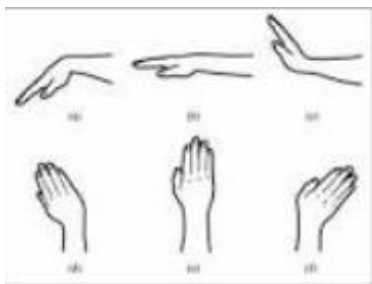
### WHY CONTINUE TO GARDEN ?

It is good for us physically and mentally, it provides aerobic and strength-building exercise, cardio exercise, builds muscles and helps maintain bone density, is mentally stimulating, emotionally satisfying and builds bonds and friendships.

### WHAT SHOULD AN ERGONOMIC TOOL DO?

- Enhance the performance, productivity and quality of your work
- Reduce or eliminate your discomfort, fatigue or physical stress while you work
- Prevent accidents or injuries while doing the task
- Ideally – bend the tool, not the wrist
- Should be less than 3 pounds
- Tool's center of gravity aligned with center of hand
- Handles are padded, with a non-slip texture
- Handle diameter should be  $\approx 1.5$ "
- Spring &/or ratcheting action
- Shaft of long tools is bent so upper part is more horizontal
- Second hand grip along shaft

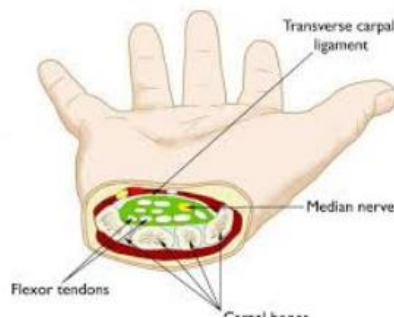
### NEUTRAL HAND POSITIONS



Bending the hand downward is called "flexion." Bending the hand upward is called "extension." Normal wrist flexion is approximately 70 to 90 degrees.

Normal wrist extension is approximately 65 to 85 degrees. Keep hand in a neutral position to minimize friction on the tendons and nerves in the carpal tunnel and reduce the chance of swelling of the tendons

### CARPAL TUNNEL SYNDROME (CTS)



### CAUSES

- Repetitive gripping, pinching, or pressure on the palm of the hand causes swelling of tendons in the carpal tunnel and pinching of the nerves serving the fingers

### SYMPTOMS

- Pain, numbness, tingling in the thumb and first two fingers due to pinched nerves through the carpal tunnel in the palm
- Symptoms often occur a number of hours after the repetitive task is performed but go away after a few hours

If the repetitive task continues day after day:

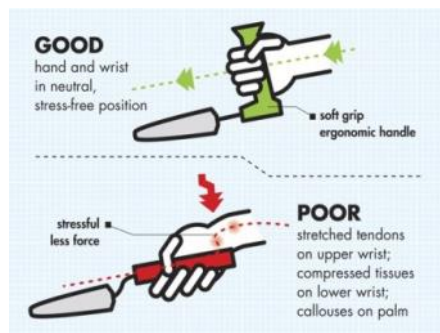
**THE PAIN CAN BECOME A PERMANENT CONDITION!**

### TREATMENT

- Invasive surgery to relieve the pressure on the nerves and constant pain
- Can result in a permanent decreased strength in the hand

### AVOIDANCE / PREVENTION

- Keep your hand and wrist in a neutral position
- Switch hands if possible to spread out the work load
- Vary your activities to use different muscle groups
- Don't use your palm as a hammer
- Use ergonomic tools that are wide and span the palm
- and offer mechanical assistance to reduce palm pressure
- Be aware of other hobbies that can contribute to CTS



*Minimize stress to the palm and keep hand in a neutral position*





### MECHANICAL ASSIST TOOLS : REDUCE FORCES

- 2-handled tool: 2 – 3.5 inches between open and shut & spring loaded\*
- Ratchet Pruners
- FlexDIAL Pruners
- Sharp Knives

*These tools help if you have limited hand strength!*



### DO YOU HAVE TO BUY EVERYTHING NEW?

No. Retrofit whenever you can using tape, bicycle handles, rubber grips, padded or grippy gloves. There are adaptors for several kinds of tools.



### NON-SLIP GRIP : MINIMIZE FORCES ON HAND

Make anything non-slip by using a spray of canned rubber on a handle to decrease the tendency to slip. It also comes in cans for dipping handle. Or wrap around grippy tape like that used on baseball bats.



### HOSE NOZZLE LOCK POSITION : MINIMIZE FORCES ON HAND

Avoid static pressure on fingers and palm : Hose nozzles  
Quick disconnect attachment for hose and nozzles

### WEEDING

Prevention – mulch, or weed cloth & mulch  
Tools such as Cobra™



### THE “GOLDEN ZONE”

Work in the “Golden Zone” \* shoulders to thighs and 90° from the center of your body

- Keep heavy objects close to the body
- Use stools, kneelers or ladders to get to work area
- Employ planters and vertical gardens to minimize bending (Liberty Mutual Ergonomic Research – Stover Snook)

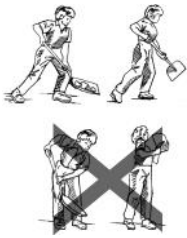


### LIFTING

- Limit weights to comfortable loads with a combination of legs and back\*
- Typically, 35 pounds for women and 45 pounds for men
- ( Less if you are a senior, have osteoporosis or are carrying long distance)
- Avoid static loads (leaning over for too long)
- Buy garden supplies in quantities you can easily lift, carry and use
- Lifting/Carrying aids : Pot lifter, wheeled carts, two-wheeled wheelbarrows, snow “sleds” and golf bags.

### DIGGING

Our bodies are not really meant to twist with heavy loads – It causes damage to the disc material between the vertebrae.



### FLORAL SHOVEL

“Floral shovel” great for digging small holes while in a standing position :

- Uses larger muscle groups
- Less weight per shovel-full
- Avoids carpal tunnel risks of using a hand trowel
- Avoids bending and static loads
- Great for tough Vegas soils (rocks, clay, caliche)
- Strength tool (shovel) –1.5 – 2 inch wide handle diameter\*



### TOOL MAINTENANCE

Keep tools clean, sharp, lubricated and useable. Clean tools after use on irritating sap (euphorbia rigida – gopher plant). Mark tool handles with brightly visible colors or brightly colored ribbons.

Just because it says “ergonomic” doesn’t mean it’s right for all users. It’s not ergonomic for you if it’s uncomfortable for you.

*Ergonomic Tools : No one tool is right for everyone!*

*Goldilocks Rule : Choose the tool that is just right for you!*

**WHAT IS WRONG WITH THIS TOOL?** From Gardenista blog :

*“Garden Tools : Which Trowel or Weeder is Best for You?”*



- *Narrow handle*

- *Unpadded handle*
- *Sharp edges on handle*
- *Metal handle could get slippery*
- *Top of blade is sharp*
- *Dark metal gets hot in the sun*
- *Heavy*
- *Dark colored tool is easy to misplace in the garden*

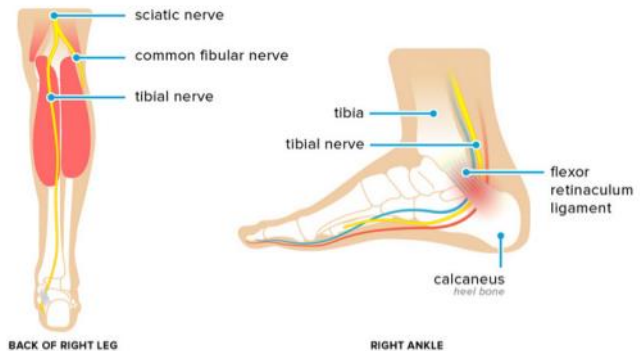
### PERSONAL PROTECTION

- *Hat, sunglasses, long sleeved, light-colored, loose clothing, sturdy shoes*
- *Gloves : Vary gloves depending on the job*
- *Impervious – soil, irritating sap (cloth backing?)*
- *Leather – prickly or thorny plants*
- *Gauntlets – large prickly or thorny plants*
- *Grippy palm – slippery / wet items*
- *Heavy jersey gloves – rough items like branches*
- *Nitrile surgical – delicate work*
- *Barrier Creams – extra level of protection !*

### LADDER SAFETY

- *Is your ladder stable?*
- *Three point contact*
- *Have your tools at hand (tool belt?)*
- *Keep your cell phone with you*
- *Solid, level surface (wood or blocks below)*
- *Proper lean ratio (4/1) of a straight ladder*
- *Safety feet*

### TARSAL TUNNEL SYNDROME SYMPTOMS



- Pain, numbness, tingling, burning, sharp shooting pain in the sole of the foot or inside the ankle
- Symptoms often occur a number of hours after the repetitive task was performed

### CAUSES

- Repetitive pressure on the sole of the foot causes swelling of tendons in the tarsal tunnel
- Extended use of ladders and/or improper footwear on ladder

### PREVENTION

- Wear shoes with good arch support
- Wear shoes with a sturdy sole if spending time on a ladder or on uneven surfaces (steel shank safety shoes)
- Use ladders with flat rungs not round rungs
- Span ladder rung with ball and heel of foot if possible
- Choose dwarf varieties of trees
- Trim plants and trees to avoid the use of ladders if possible



## GARDEN DESIGN

- Avoid steep slopes and stairs
- Walking areas should be well-illuminated at night
- Be aware of situations that could lead to a fall, such as loose gravel
- Utilize raised beds, planter boxes, vertical boxes, and trellises to avoid bending

## GARDEN EFFICIENCY

- Maintain tool stations around the yard so your basic gardening tools are always handy or use a tool belt, an apron with pockets, a gardener's apron, a bucket apron, tool satchels, tool carts.
- Stage attractive waste containers in the yard as needed
- Keep veggies like tomatoes and herbs close to the house for easy access while cooking

## IRRIGATION OPTIONS

- Limit the use of watering cans
- Conveniently-located hose bibs
- Quick disconnect hoses/attachments
- Drip irrigation systems
- Hanging baskets on irrigation system

## CHOOSE PLANTS THAT REQUIRE LESS WORK

- Native plants – can tolerate the poor, alkaline soil, temperature extremes and low water availability
- Desert-adapted plants – can tolerate native / amended soils, temp extremes (if placed properly to get some shade) and have low to moderate water requirements
- “Exotic” / Non-native plants – must be “babied” with potting soil, special placement (sun, temp and wind) and/or bring in during temp extremes and may have higher water needs and be more prone to disease
- Place plants with similar watering needs on the same irrigation system
- Limit exotics to a favorite few !

## Projected Casualties of Climate Change In Las Vegas, NV by 2025\*

Scientific Name	Common Name	Plant Type	Still Within Tolerance Range in 2025?	Still Tolerant in 2055?
Abelia x grandiflora	Glossy Abelia	Shrub	N	NN
Cupressus sempervirens	Italian Cypress	Tree	N	NN
Euonymus japonica	Euonymus (Evergreen)	Shrub	N	NN
Euonymus japonica 'Aureo-Variegata'	Euonymus (Gold Spot)	Shrub	N	NN
Euonymus japonica 'Microphylla'	Euonymus (Box-leaf)	Shrub	N	NN
Fraxinus oxycarpa 'Raywood'	Ash (Raywood)	Tree	N	NN
Juniperus chinensis 'Sea Green'	Juniper (Sea Green)	Shrub	N	NN
Juniperus horizontalis 'Wiltonii'	Juniper (Blue Carpet)	GC	N	NN
Juniperus sabina 'Buffalo'	Juniper (Buffalo)	GC	NN	NN
Lavandula species	Lavender*	Shrub, Perennial	N*	NN*
Photinia x fraseri	Redtip/Fraser's Photinia	Shrub	N	NN
Prunus cerasifera atropurpurea	Purple Leaf Plum	Tree	NN	NN
Pyracantha coccinea	Firethorn	Shrub	N	NN
Raphiolepis indica	Indian Hawthorn	Shrub	N	NN
Thuja occidentalis	Arborvitae	Shrub	NN	NN
Ulmus parvifolia	Lacebark Elm	Tree	N	NN

## Projected Casualties of Climate Change In Las Vegas, NV by 2055\*

Scientific Name	Common Name	Plant Type	Still Within Tolerance Range in 2025?	Still Tolerant in 2055?
Aptenia cordifolia	Hearts and Flowers / Red Apple Ice Plant	GC, Succulent	Y	Y
Buxus microphylla 'Japonica'	Japanese Boxwood	Shrub	Y	Y
Diets bicolor, Diets iridioides, Moraea iridioides	Fortnight Lily (African Iris)	Perennial	Y	Y
Drosanthemum cooperi	Purple Iceplant	GC, Succulent	Y	Y
Echinocactus grusonii	Golden Barrel Cactus	Cactus	Y	Y
Fraxinus velutina	Ash (Arizona)	Tree	Y	Y
Fraxinus velutina glabra	Ash (Modesto)	Tree	Y	Y
Fraxinus velutina 'Rio Grande' or 'Fan-tex'	Ash (Fan-Tex)	Tree	Y	Y
Ligustrum japonicum	Waxleaf/Japanese Privet	Tree, Shrub	Y	Y
Ligustrum lucidum	Glossy Privet	Tree, Shrub	Y	Y
Liriope muscari	Lily Turf	Perennial	Y	Y
Olea europaea	Olive Tree	Tree	Y	Y
Pinus eldarica	Pine (Mondell/Afghan)	Tree	Y	Y
Pinus halepensis	Pine (Aleppo)	Tree	Y	Y
Pittosporum tobira	Mock Orange (Japanese)	Shrub	Y	Y
Pyracantha koidzumii 'Santa Cruz'	Santa Cruz Pyracantha/Firethorn	GC	Y	Y
Rhus lancea	African Sumac	Tree	Y	Y
Rosa species	Rose*	Shrub, Vine	Y	Y
Salvia greggii	Sage (Autumn)*	Shrub	Y	Y
Vitex agnus-castus	Chaste Tree	Tree	Y	Y
Xylosma congestum	Xylosma [shrub]	Tree, Shrub	Y	Y
Yucca recurvifolia	Weeping/Pendulous Yucca	Succulent	Y	Y

## HEAT-RELATED ILLNESSES

- Garden early in the day in the summer time
- Know your limitations – don't over do it
- Be aware of heat-related illness symptoms :  
Heat Rash, Heat Cramps / Heat Exhaustion including sweating, cramping of muscles, headache, irritability, confusion, thirst, dizziness and nausea. Heat Stroke is characterized by a lack of sweating, incoherence, convulsions and early loss of consciousness. **A TRUE MEDICAL EMERGENCY !**

## PREVENTION

Get acclimatized to the heat slowly over # of weeks and start over when you are away for a few weeks, use various cooling techniques such as cooling bandanas, wide-brimmed hats, loose, light-colored clothes. You can also wet your clothing down, work in the shade (portable tents) and place an electric fan nearby or take frequent breaks in the shade. Stay hydrated – avoid coffee, tea and alcohol, eat small frequent meals before symptoms arise, carry a cell phone when working alone, utilize the buddy system wherever possible.

## SUMMARY

- Use ergonomic tools to minimize stress and strain.
- Vary your tasks during the day.
- Use raised beds to reduce bending.
- Use soaker hoses or a sprinkler system for irrigation.
- Choose low maintenance plants such as native perennials.
- Ask assistance with tasks that are difficult or might cause strain.
- Buy garden supplies in quantities you can easily lift and carry
- Take frequent breaks and rotate between jobs to decrease strain on back.
- Be conscious of twisting motions.
- Be aware of situations that could lead to a fall, such as loose gravel
- Protect yourself from the sun, take frequent breaks in the shade, hydrate.

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  4. "OSHA Fact Sheet : Protecting Workers from the Effects of Heat," DTSEM FS-3743 08/2014.

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## Update of Latest Occupational Exposure Limits: DNELs, TEELs and Others

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**Abstract:** Over the past 10 years, the European Union has required chemical suppliers to develop occupational exposure limits for the major chemicals used in commerce. This applied to over 3,000 chemicals.

These new DNEL (Derived No Effect Level) occupational exposure limits were to be based on current science and not previous OEL standards. These health effects-based standards include both long-term and short-term exposures.

The result is the most up-to-date toxicological evaluation of chemical exposure effects for workers and recommended exposure limits.

In the US, a similar toxicological review of the effects of chemicals has been conducted by the Department of Energy for over 100,000 workers in DOE facilities.

Unfortunately, US industries and many other countries have not embraced these up-to-date recommended exposure limits.

This presentation compares these two sets of exposure limits to current ACGIH TLVs and other chemical standards.

### A. HISTORICAL PERSPECTIVE ON GLOBAL OCCUPATIONAL EXPOSURE LIMITS

Adverse health effects from occupational exposure to chemicals has been known for thousands of years. The Romans noted effects from lead and asbestos and later arsenic. A list of "poisons" that have been used for various purposes was well known.

Establishing occupational exposure limits for some of these chemicals started over 150 years ago. A brief historical list is shown below. It is interesting to note that indoor air quality standards were recommended first because this research was funded by wealthy individuals to protect their health in their castles. The first actual chemical exposure standards for workers was set by Germany for the manufacturing of gas warfare agents (1912). The first peace-time occupational exposure limit was for quartz, which is still an exposure problem over 100 years later.

- 1849 : In Germany, Peterkoffer proposed first exposure standard for carbon dioxide of 1,000 ppm.
- 1874 : English Army Surgeon F. de Chamont proposed a carbon dioxide IAQ standard of 200 ppm above outdoor levels (300 ppm), approximately 500 ppm. Note: CO<sub>2</sub> levels in the outdoor air are now 415 ppm and are causing global warming and climate change.
- 1883 : Max Gruber, of the German Hygienic Institute at Munich, proposed a carbon monoxide standard of 200 ppm.
- 1912 : Kobert (Germany) published a list of acute exposure limits for 20 hazardous industrial gases.
- 1916 : South Africa published an exposure limit for quartz at 8.5 mppcf (million particles per cubic foot.)
- 1917 : U.S. Bureau of Mines established an initial limit for quartz at 10 mppcf.
- 1921 : U.S. Bureau of Mines published exposure limits for 33 substances.

- 1930 : Russia published first MAC (Maximum Allowable Concentration) list with 30 chemicals. By 2008 this list covered over 3,500 chemicals.
- 1938 : Germany published a list of about 100 OELs (Occupational Exposure Limits.) Today this list contains over 1,000 chemicals.
- 1941 : American National Standards Institute (ANSI) published the first U.S. exposure standard for carbon monoxide of 100 ppm (58 years after Germany.)
- 1942 : The American Conference of Governmental Hygienists (ACGIH) published their first table of 63 TLVs® (Threshold Limit Value) exposure limits. The list is published annually. Today this list contains almost 700 chemicals.
- 1949 : India passed the Factories Act with their first table of 49 exposure limits.
- 1950 : The People's Republic of China published their first list of exposure standards. Today China's list contains over 400 chemicals.
- 1970's : Other countries adopt the latest version of the ACGIH TLVs® as the basis for their exposure standards in occupational safety and health laws.
- 1978 : AIHA® publishes the first Workplace Environmental Exposure Level (WEEL) Guides.
- 1978 : AIHA® publishes *Occupational Exposure Limits – Worldwide*. Unfortunately, it only lists chemicals for which the US has standards and not all the chemicals other countries regulate that the US does not.
- 2000 : First list of 1,000 TEELs (Temporary Emergency Exposure Limits) by the US Dept. of Energy (DOE). Standards were calculated based on toxicological modeling and published toxicological data. Today this list contains over 3,000 chemicals.
- 2003 : Other than the United States and India, virtually all other



countries update their OELs every 1-5 years.

- 2005 OEHCS, Inc. (Occupational & Environmental Health Consulting Services) published “Global Occupational Exposure Limits for Over 6,000 Specific Chemicals.”
- 2006: The EU passes the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulations requiring manufacturers to develop Derived No Effect Levels (DNELs), Derived Minimal Effect Levels (DMELs), etc. for all chemicals produced or imported in quantities of more than 10 tons/year.
- 2008 AIHA published their ERPGs (Emergency Response Planning Guidelines) to deal with short term exposure situations commonly found in emergencies such as large chemical leaks or spills.

ERPG-1: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective action.

ERPG-3: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

## B. MOVING TO TOXICOLOGY-BASED EXPOSURE LIMITS

A significant historical perspective is that of the ACGIH TLVs®. During the 1970s, many developing countries established their hygiene standard regulations by adopting the ACGIH TLVs® that were current at the time. Following this initial inception, these countries continued to use the ACGIH TLVs® as a significant reference in updating their existing chemical exposure standards. The chemical exposure limits for almost 1 billion workers worldwide have been based upon the ACGIH TLVs®.

The problem with the original TLVs was that they were “opinions” of US industrial hygienists as to what concentrations of chemicals employees did not seem to object to and what could be economically affordable.

In 1992, ACGIH, because of this “opinion” controversy, developed a document titled “Documentation of the TLVs” to substantiate the levels in the TLVs. The “Documentation of the TLVs” contained references to published exposure monitoring studies and very limited toxicological data to substantiate their exposure limits.

At the same time, both Germany and Russia were establishing their own exposure limits called Maximum Allowable Concentrations (MACs). Their exposure standards included almost 1,000 chemicals, almost twice that of the TLVs. Like the TLVs, most of their exposure standards were similar in evolution – based on employee tolerance, rather than toxicology.

In 2000, the ACGIH was sued by US manufacturers to stop implying that the TLVs® were employee exposure standards. ACGIH could not afford to fight this litigation and hence, now state that their “standards” are simply guidelines. All of these exposure standards were not based on a comprehensive toxicological model of humans and still lacked the hard science of modern day toxicology modeling based on toxicological studies.

The first attempt at developing a database of chemical exposure limits based on toxicology modeling was started by the US Department of Energy in 2000. These DOE occupational exposure limits were known as TEELs. Temporary Emergency Exposure Limits. This toxicological modeling covered the different classes of exposure limits. There were 4 types of limits TEEL-1 through TEEL-4. TEEL-1 was similar to an 8-hour Permissible Exposure Limit - Time-Weighted Average (PEL - TWA). TEEL-2 was a 15-minute Short Term Exposure Limit (STEL), TEEL-3 lists Ceiling Limits (CL), and TEEL-4 are levels that are Immediately Dangerous to Life and Health (IDLH.)

Originally, the TEEL method used only hierarchies of published concentration limits (e.g. PEL or TLV-TWAs, STELs, CLs, and IDLHs) to provide estimated values approximating TEELs. However, there were hundreds to thousands of chemicals for which there are no exposure limits. For these chemicals, published toxicity data were used to set TEELs. [e.g. LC(50), LC(L0), LD(50) and LD(L0) for TEEL-3 and TC(L0) and TD(L0) for TEEL-2 toxicity parameters, such as LD50, LDLO, etc.] These TEELs were calculated from animal toxicology studies after making adjustments to extrapolate experimental results from animals to humans. For example, Table 3.2 (from U.S. Department of Energy (2008) titled Temporary Emergency Exposure Limits: Methods and Practice, DOE-HBK-1046-2008) shows the adjustment (concentration reduction) for Ceiling Limits and 15 STELs

**Adjustment Factors to Derive Toxicity-Based TEELs  
from Human-Equivalent Toxicity Concentration Values**

SPECIES	TEEL-3				TEEL-2	
	LC <sub>50</sub>	LC <sub>L0</sub>	LD <sub>50</sub>	LD <sub>L0</sub>	TC <sub>L0</sub>	TD <sub>L0</sub>
HUMAN ONLY	-	50	-	1	10	-
RAT ONLY	100	100	2	-	15	1
ALL DATA	100	100	2	1	15	1.5

Source: Craig et al., 2000

The toxicology model and its assumptions were freely available and published on the internet. This toxicology model was based on a broad review of all of the toxicological literature and the current science of inhalation toxicity. In general, the toxicology-based exposure limits were similar to the levels in the TLVs, but the DOE OEL list contained exposure limits for almost 3,000 chemicals, far more than the 650 chemicals listed in the ACGIH TLVs. Subsequently, default assumptions based on statistical correlations of AIHA ERPGs at different levels (e.g. ratios of ERPG-3s to ERPG-2s) were used to calculate TEELs where there were gaps in the data. This was a major step forward in establish-

ing science- based exposure limits and, at the same time, establishing exposure limits for a majority of chemicals in the workplace. The US DOE updates the TEELs on an annual basis, adding new chemicals as they begin to use them.

In 2006, the next major step in toxicological based exposure standards occurred.

The European Union (EU) passed the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulations requiring

manufacturers to develop Derived No Effect Levels (DNELs), or Derived Minimal Effect Levels (DMELs) for all chemicals produced or imported in quantities of more than 10 tons/year. The toxicology models and assumptions are published on the internet and easily available for review. (Guidance on Assessment Factors to Derive a DNEL ECETOC TR. 110. 211 pages.)

### C. THE EXPOSURE STANDARD DEVELOPMENT RESPONSIBILITY OF CHEMICAL MANUFACTURERS

History has shown that chemical exposure standards have typically been developed by various governmental agencies often times with different agendas. This has resulted in a “piece meal” approach to setting chemical exposure standards that do not cover all the chemicals used in “commerce.” The point being that chemicals used in commerce are most likely to result in significant employee exposure.

Russia was the first country to set exposure standards for the major chemicals produced or in commerce. (This covers over 3,500 chemicals today.) The 2nd Agency to attempt to regulate all the chemicals used in their facilities was the US Dept of Energy. (This covered over 3,000 chemicals.)

However, the weakness in this historical government regulatory establishment system is that some chemical manufacturers may have more information about the potential health hazards of a chemical they manufacture than they disclose to the public or for publication. Further, legally, chemical manufacturers are liable for the adverse health effects of the chemicals they produce. Given these two facts, it makes sense that chemical manufacturers should establish the “safe” level of exposure for the chemicals they produce and release into commerce. By having manufacturers set the exposure limits, manufacturers are the clear and responsible party for exposures to their products. By setting “safe standards” manufacturers could also potentially limit their liability.

In 2006, given this historical and legal perspective, the EU adopted this philosophy and required chemical manufacturers to establish both DNELs and DMELs for the chemicals they produce and distribute. This is required for all chemicals produced or imported in quantities of more than 10 tons per year. Initially, it was thought that this would be approximately 3,000 chemicals. Today, it covers over 10,000 chemicals and the list is still growing.

#### Why are the DNEL Different?

Very simplistically, the DNELs are comprehensive exposure assessments. They address acute or repeated exposure, different routes of exposure (inhalation or skin contact), differentiate between local and systemic health effects, and differentiate between worker exposure and general population exposure as appropriate for the intended use. Theoretically, up to 15 DNELs may be required for a specific chemical. The DNELs that are actually required will depend on the use selected (points of departure) and the assessment factors (AF) subsequently applied.

DNELs are defined as “safe exposure levels” for threshold effects. These are levels above which the exposed population will begin to exhibit symptoms of exposure. Such “safe levels” cannot be defined for non-threshold effects such as genotoxic carcinogens or mutagenic effects. For non-threshold effects, a DMEL needs to be calculated.

### D. TRENDS IN GLOBAL OCCUPATIONAL EXPOSURE LIMITS

Presently, there are approximately 3,000 DNELs that have been established.

However, globally, amongst all the countries and governmental agencies, there are occupational exposure standards for over 6,000 chemicals. Of the 6,000+ OELs worldwide, over 4,200 are regulated in more than one country. Interestingly, the application and adjustment of OELs in some countries vary significantly.

Here is a list of some of the more significant variations.

1. Germany has the most advanced system for developing OELs (MACs). They have an occupational hygiene database for storing all empirical occupational hygiene data. As of 2005, the database had over 1,000,000 data sets. This exposure data is used in conjunction with the national health care data system to look for health effects of chemicals in workers and for other toxicological studies.
2. Russia has OELs (MACs) for more substances than any other country; over 3,500, including approximately 100 OELs for specific species of mold and bacteria. The MACs in Russia are designed to minimize not only adverse health effects for the majority of workers but also for the workers’ future generations.
3. The US Department of Energy has the most OELs that are calculated based on animal toxicity. They also use data from the Russian OELs.
4. Singapore and the Philippines define STELs for all chemicals using a multiplier of the OEL when specific STELs have not been established.
5. The largest number of No Observable Effect Level (NOEL) standards have been set by the State of California and Santa Clara County, California Health Based Exposure Limits (HBELs.)
6. Many of the OELs in other countries are lower than the current ACGIH TLVs®.
7. The OEL definitions in a number of countries clearly state that OELs do not protect sensitive workers.
8. Hungary has the most comprehensive OELs for dealing with carcinogens and mutagens. They require toxicological addition of these combined exposures to assess exposure risk.
9. Japan differentiates between inhalation sensitizers and skin sensitizers.
10. Venezuela requires an adjustment of the OELs based upon a work week that is longer than 40 hours, (in addition to the adjustments typically made for a work day that is longer than an 8 hours.)
11. Austria established OELs for highly-hazardous substances that averages employee exposures over a one year period.
12. New Zealand lists OELs for approximately 100 chemicals that they have not set standards for but are regulated by other countries.
13. Some countries, such as New Zealand, adjust the OELs for respiration rate of the worker.
14. A number of countries adjust their OELs for altitude.
15. A number of countries adjust their OELs for standard temperature and pressure.
16. A number of countries automatically adjust OELs for a 48-hour work week.
17. Some European countries have listed certain chemicals with an OEL of “0” This is intended to mean that those chemicals are banned from use in their respective countries.

### E. SO WHAT STANDARDS SHOULD WE USE OR FOLLOW?

Given the myriad of exposure standards, what OELs should an occupational hygienist follow? Clearly, the starting point for any exposure assessment is to follow the legally-required exposure standard in the employee’s country. However, this is not sufficient due diligence. All existing exposure standards that are more restrictive than a country’s regulatory standards should always be considered. Below is an example of an occupational exposure assessment for an ink printing operation. It shows the specific chemical and the applicable exposure standards.

As you can see in the following tables, employee exposure standards for specific chemicals are found in numerous different sources. Sometimes the new DNEL is the lowest exposure standard. Sometimes the TEEL is the lowest standard and, for most chemicals, it varied by country. There is no simple global resource for this information for all countries.

## Listing of Global Occupational Exposure Limits (OELs) and Outdated OSHA PELs for the Chemicals Identified in this Assessment

CAS	Chemical	GLOBAL OELs (mg/M <sup>3</sup> )						EU DNEL
		DOE TEEL	NIOSH REL	OSHA PEL	Min	Median	Max	
Chemicals Where the DNEL is the Lowest Exposure Standard								
64742-95-6	Naphtha	NE	NE	2000	NE	NE	NE	100
64742-94-5	Naphtha	NE	NE	2000	NE	NE	NE	192
110-54-3	n-Hexane	50	180	1800	70	175	1800	75
64-17-5	Ethanol	1000	1900	1900	1000	1880	1920	463
7397-62-8	Hydroxyaceticacidbutyl ester	NE	NE	NE	NE	NE	NE	59
1843-05-6	Octabenzene	NE	NE	NE	NE	NE	NE	6.6

### Chemicals Where the TEELs are the Lowest Exposure Standard

123-42-2	Diacetone Alcohol	50	240	240	96	240	241	66
91-20-3	Naphthalene	10	50	50	40	50	53	25
106-67-8	1,3,5 Trimethylbenzene	140	NE	NE	NE	NE	NE	NE
108-88-3	Toluene	50	375	750	50	190	600	192
5989-27-5	D-Limonene	30	NE	NE	140	140	140	33
107-98-2	PGME	100	360	NE	100	369	375	369

### Chemicals Where the Lowest Exposure Standard is in a Specific Country

67-63-0	Isopropyl Alcohol (IPA)	400	980	980	350	980	1230	500
142-82-5	n-Heptane	440	350	2000	350	1600	2100	2085
106-97-8	4-Butane	800	1900	1900	300	1900	2400	NE
67-64-1	Acetone	1000	590	2400	300	1200	2400	1210
141-78-6	Ethyl Acetate	400	1400	1400	200	1400	1500	734
78-93-3	Methyl Ethyl Ketone (MEK)	200	590	590	145	590	600	600
100-41-4	Ethyl benzene	100	435	435	50	435	442	77
1330-20-7	Xylene (p, m)	100	435	435	50	221	440	77
95-47-6	Xylene (o)	100	435	435	50	221	435	221
98-82-6	Isopropylbenzene	50	245	245	20	121	250	100
526-73-8	1,2,3 Trimethylbenzene	25	NE	NE	20	100	125	NE
1589-47-5	2-Methoxy-1-Propanol	NE	NE	NE	19	75	78	NE
79-01-6	Trichloroethene	100	131	537	10	269	550	55
80-62-6	Methyl methacrylate	100	10	410	10	210	410	208
95-63-6	1,2,4 Trimethylbenzene	25	NE	NE	10	100	125	100
108-94-1	Cyclohexanone	50	100	200	10	100	820	40
108-90-7	Chlorobenzene	30	NE	350	5	47	350	23

DOE (TEEL - 1) US Department of Energy Temporary Emergency Exposure Limit - The latest DOE employee exposure limits for US 3,000 different chemicals.

NIOSH (REL) US National Institute of Occupational Safety and Health Recommended Exposure Limit - most of these are 30 years old and for are only available for a few chemicals.

US OSHA (PEL) Permissible Exposure Limit - 40+ year old legal OSHA exposure limits. The most out of date OELs in the world.

MIN- minimum exposure limit set by any country.\*

MEDIAN- median exposure limit agreed to by the largest number of countries.\*

MAX- maximum exposure limit set by any country.\*

EU DNEL – European Union Derived No Effect Level - The latest employee exposure limits established in the EU for over 3,000 different chemicals.

NE - None Established

\*(The Min, Median and Max values are found in "Global Occupational Exposure Standards for Over 6,000 Chemicals, 2<sup>nd</sup> ed. Brandys and

Brandys, OEHCS Publications, 2008.)

What these tables show is that assessing employee chemical exposure using the latest or most comprehensive information is a complex and time-consuming task.

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## DOP Testing of HEPA Filters: Is There a Problem?

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**Abstract:** HEPA-filtered equipment is an important engineering control used in a wide variety of industries including asbestos abatement, lead mitigation, mold remediation, pharmaceutical cleanrooms and the nuclear industry.

Research on portable HEPA-filtered equipment at the National Institutes of Health over the past 5 years has shown significant performance problems with this equipment. It cannot be assumed that because a piece of equipment contains a HEPA filter that the device filters the air at HEPA effectiveness.

This research additionally has shown that the standard method for evaluating HEPA-filtered equipment –the DOP aerosol method has inherent limitations. This equipment is useful for finding the locations of leaks in the HEPA filter media but may not be appropriate for assessing overall effectiveness of the HEPA-filtered unit.

This research also showed that portable HEPA-filtered equipment needs to be regularly tested to ensure its effectiveness at removing hazardous particulates from the air.

This presentation discusses the research findings and makes recommendations for alternative methods for in-field assessment of HEPA-filtered equipment.

This presentation also discusses the new ANSI Z9.9 standard on testing portable HEPA-filtered equipment and its classification system.

HEPA-filtered equipment is an important engineering control used in a wide variety of industries including asbestos abatement, lead mitigation, mold remediation, pharmaceutical cleanrooms and the nuclear industry.

### A. German Gas Masks

The development of the HEPA filter dates back to the 1940s and WWII. They were originally developed by Germany using asbestos fibers as the filtration media in gas masks. In the early days of World War II, the British sent filter paper extracted from captured German gas mask canisters to the U.S. Army Chemical Warfare Service Laboratories (CWS) in Edgewood, Maryland. The German filter paper was made of finely ground up asbestos dispersed in esparto grass. The paper had unusually high particle retention characteristics, acceptable resistance to airflow, good dust storage, and resistance to plugging from oil-type screening smokes (a deficiency of the resin-wool filters then used by the British forces).

The U.S. Army Chemical Warfare Service and the U.S. Naval Research Laboratory developed a similar "collective protector" filter paper using a cellulose-asbestos media. The U.S. Army Chemical Corps' "collective protector" filters were also known as "absolute", "super-interception", and "super-efficiency" filters. However, in 1961, the generic acronym "HEPA filter" was coined by Humphrey Gilbert, a former Manhattan Project safety engineer. It came from the title of a 1961 Atomic Energy Commission (AEC) report called "High-Efficiency Particulate Air Filter Units, Inspection, Handling, Installation." Since that time, the term "absolute filter" has fallen into disuse because it is not technically accurate.

### B. U.S. Nuclear Weapons Manufacturing

Large-size HEPA filters were first used to remove radioactive particles from the air during the United States Manhattan Project while researching and constructing the first atomic bombs. They were developed by Arthur D. Little Co. <http://www.approvedgasmasks.com/hepa-filters.htm>

In developing these HEPA filters, researchers focused on the ability to capture solid particles in the air. These particles were created through the condensation of gases and liquid aerosols into solid matter during the production of weapons-grade materials. Researchers considered the condensation nuclei of radioactive iodine vapors to be the most harmful exposure risk to research personnel because iodine is taken up by the thyroid and can produce thyroid cancer. The filters were tested for their efficiency using Dioctyl Phthalate (DOP) aerosol with a mean aerodynamic diameter of 0.3 micrometers.

### C. U.S. Nuclear Energy Reactors and the “Space Race”

During the 1950s, the nuclear weapons production and the emerging nuclear power generation industry were the driving force for further development of HEPA filtering technology. The U.S. Atomic Energy Commission (AEC) developed HEPA filters using a fiberglass-asbestos media that was more durable than the previous cellulose-asbestos filter material. As the space race began in 1958, the U.S. developed the first all-fiberglass HEPA filters. However, fiberglass-asbestos filters continued to be used in some applications through the 1970s.

By this time, the Army and the AEC were well aware of in-use performance problems of HEPA filters. Although these filters were designated as HEPA, during actual use, they were found to be less effective. Consequently, in order to insure the safety of workers in nuclear weapons production, they needed to test the performance of HEPA filters to insure that they actually performed to the theoretical specification. In 1962, The AEC set up its first Filter Test Facility at the Hanford graphite-mediated weapons grade uranium and plutonium production reactor facility in Hanford, Washington. The Hanford site stayed in production until September 2009 when it was shut down for safety reasons. The Hanford reactor was the same type of reactor that caught fire during “safety testing” in Chernobyl in 1986.

In 1957, based on reports that defective HEPA filters were being supplied to its facilities, the AEC had samples of HEPA filters from its facilities sent to its Edgewood testing laboratory for analysis. Edgewood found that 7 out of 12 filters it received had obvious visible defects right out of the original suppliers’ shipping cartons. Sampling of other unused filters that remained at AEC found a similar defect rate.

Based on these findings, AEC initiated a Quality Assurance Program and testing requirement for all filters delivered to its facilities. This 100% incoming testing requirement continues to today at DOE facilities. Interestingly, DOE’s experience with performance problems of new HEPA filters has only somewhat improved since 1957. In 2007, 50 years later, instead of the previous 58% failure rate, DOE was experiencing a 20% failure rate of incoming new filters.

The implications of DOE’s current experience are significant. If 20% of the HEPA filters supplied to DOE are defective (from manufacturers who know that the filters are going to be 100% tested), then the defect rate of HEPA filters supplied to the asbestos, mold and other non-DOE end users is probably the same or higher. HEPA filter technology spread to the development of cleanrooms for technologies in other industries including aerospace, nuclear power, pharmaceutical production and later, in transistor and integrated circuit production.

In 1974, responding to the change in filter media technology to fiberglass, the AEC issued RDT M-16-3T “HEPA Filter Medium, Glass Fiber (MIL-F-51079 with Modifications and Additional Requirements.) In 2003, the requirement of Mil-F-51068 and Mil-F-51079 were incorporated into ASME AG-1, Section FC. Committee on Nuclear Air and Gas Treatment (CONAGT). Today, the U.S. nuclear industry’s HEPA filter design and construction specifications in AG-1 are essentially the same as those in England. These newer specifications reflected that HEPA filters are now made of many different materials including fiberglass, Teflon, nylon, ceramic sintered metal, polypropylene, polyethylene terephthalate and other materials.

### D. PHEAF Equipment

Most of the HEPA-filtered equipment described above are stationary systems that are installed in laboratories or manufacturing facilities. Over the past few decades, the development of the asbestos, lead, mold, illegal drug labs, other hazardous material clean-ups and fire/water damage remediation / restoration industries has resulted in a huge increase in the use of portable HEPA-filtered equipment. Equipment manufacturers claim that their units are “equipped with a HEPA filter” that is independently tested to be 99.97% efficient. End users assume that the device as a whole with therefore function at a 99.97% effectiveness. Unfortunately, that is rarely the case.

Portable HEPA-filtered equipment such as HEPA vacuums, air filtration devices (AFDs) and negative air machines (NAMs) is a special subset of HEPA-filtered equipment that is subject to highly-variable conditions and physical abuse. Consequently, a special acronym for this type of equipment was developed by OEHCS, Inc. PHEAF (pronounced “feef”) is an acronym for a “Portable High Efficiency Air Filtration.” A “PHEAF device” is a term that is used for air filtration equipment and vacuums that meet the overall effectiveness classes in the PHEAF standard. (Minimum of 90% effectiveness.) It is recommended that all PHEAF equipment, whether it is brand new or old, be tested for its percentage effectiveness prior to each use.

As one example, the contractor for a remediation project in a hospital in California ordered 80 new “HEPA-filtered” vacuums from a major HEPA vacuum manufacturer, because the industrial hygienist for the hospital was going to “DOP Test” all the vacuums before allowing them to be used on the project. All of the new HEPA vacuums FAILED the DOP test ! The contractor contacted the manufacturer and refused to pay for the vacuums. The manufacturer responded, “Oh, you didn’t tell us that you were going to test the HEPA vacuums. If you need them to pass the “DOP test” you have to add an additional HEPA filter on the exhaust. Normally, this is a \$200 option, but we will send an engineer out to equip your vacuums with it for free!”

Clearly, this major “HEPA” vacuum manufacturer knew his vacuums, as sold, would not pass “DOP testing.” Further, they had developed an additional HEPA filter “add on” to be able to pass this test. The failures were not due to “carbon brush particles” as many manufacturers claim, since these were brushless DC motors. Basically, these “HEPA” filter vacuums were NOT HEPA EFFECTIVE. To this day, this major “HEPA” vacuum manufacturer offers a \$200 extra filter to ensure that the unit will pass the “DOP test.”

The leakage problems with vacuums containing HEPA filters are not limited to new equipment. Testing of “real world-in use” HEPA vacuum cleaners was done at PHEAF testing training sessions in Chicago, Las Vegas and San Diego. At these training sessions, attendees brought their actual equipment to be tested. Testing of all of these pieces of equipment showed serious leakage and dust bypass. None of the devices tested were HEPA effective or even close.

### E. National Institute of Health Research

In 2013, the National Institute of Health started a long-term research study of HEPA filter performance in PHEAF equipment used as air scrubbers during a building renovation project. The initial multi-year in-field effectiveness study evaluated 85 different pieces of HEPA-equipped air filtration equipment. During this study approximately 50% of the units had their HEPA filters replaced. Consequently, this study also was able to evaluate the effect of replacing HEPA filters. This research on portable HEPA-filtered equipment over the past 5 years has shown significant performance problems with this equipment. Their research has shown that one cannot assume that because a piece of equipment contains a HEPA filter that the device filters the air at HEPA effectiveness.



A total of 85 PHEAF devices, representing 7 manufacturer models were tested from May 2012 to February 2015. Included in the data set were 340 filter tests collected over 9 testing rounds. Most of the models of AFDs were the traditional metal box design.



Average, overall capture effectiveness ranged from 41.78 to  $\geq 99.97\%$ . However, only 8% of the test results showed 99.97% effectiveness. This means that more than 90% of the time, the units were not operating at HEPA effectiveness. This research clearly showed that portable HEPA-filtered equipment needs to be regularly tested and repaired to ensure its effectiveness at removing hazardous particulates from the air.

The second significant observation this research has shown was that the standard method for evaluating HEPA-filtered equipment - the DOP aerosol test method (US Military Std. 282) has inherent limitations. Interestingly, the aerosol testing method has never been scientifically validated. The aerosol test method is useful for finding the locations of leaks in the HEPA filter media but it may not be appropriate for assessing overall effectiveness of portable HEPA-filtered units.

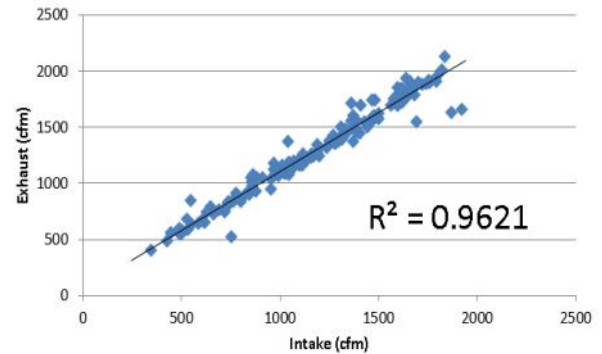


The main shortcoming of this method is that it relies on numerous air flow measurements using a hot wire anemometer. These measurements are used to calculate air the flow volume through the PHEAF device. This air flow volume is then used to set the calibration on the photometer.

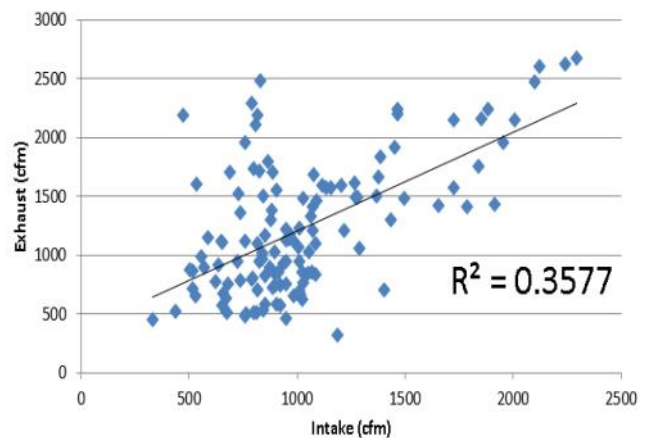


However, if the air flow measurement is inaccurate, then the calibration of the photometer is inaccurate and the subsequent test results are incorrect.

This NIH research project applied two different methods to measure air flow through PHEAF equipment. These were a balometer and a hot wire anemometer. A comparison of air flow volume measurement using a balometer instead of a hot wire anemometer showed that the balometer measurements were much more consistent ( $R^2 = .96$ ) in measuring intake and exhaust volume.



On the other hand, the comparison of intake and exhaust volume as measured with a hot-wire anemometer only had a correlation factor of ( $R^2 = .36$ ).



This NIH research clearly has shown that the classic aerosol test method used to identify leaks in HEPA filters may not be an accurate method for assessing overall PHEAF equipment effectiveness. This conclusion about the aerosol test method was also reached by the International Agency on Atomic Energy reached the same conclusion in 1985. "The American Standard methodology ANSI/ASME N510-1980 using DOP particles as test aerosol and the light scattering photometer is merely a leak testing method."

#### F. Why is PHEAF Equipment Effectiveness Testing Important?

The reason HEPA filters are required or specified is because they are designed to remove respirable size particulates from the air - particularly in highly-hazardous material applications. These are "respirable" particles in the size range to 1 to 10 microns ( $10^{-6}$  meters). Respirable particles pose the greatest inhalation hazard from both particle deposition in the airways as well as toxic exposure.

#### G. Making Regular PHEAF Equipment Testing a Requirement

The American Society of Safety Professionals ANSI Z9.9 committee developed a standard of fundamental good practices for Portable

Ventilation Systems in 2010. This is known as ANSI/AIHA/ASSP Z9.9-2010 Portable Ventilation Systems.

This committee is now considering updating this standard to include periodic PHEAF equipment testing.

This standard describes fundamental good practices related to the design, manufacture, labeling, use and application, as well as maintenance and testing of portable ventilation systems used for the control of airborne contaminants or environmental conditions.

The new ANSI Z9.9-2019 standard on testing portable HEPA-filtered equipment and its classification contains the following requirements:

5.3.3. Portable ventilation units containing air-purifying components including HEPA filters and/or chemical sorbents and/or adsorbents in operation critical situations shall be tested in-place to determine performance effectiveness when equipment is commissioned as new equipment, when air-purifying components are replaced, after any significant event that may alter the status quo of performance and after repairs or maintenance that may affect system performance, as well as on periodic basis as recommended by the manufacturer.

5.8.9.5. Testing of air-cleaning systems containing HEPA filtration used for removal of toxic contaminants shall occur in-place. Testing shall ensure that leakage in the housing, filter seals, and/or filter media when challenged with a polydisperse aerosol and measured with a light scattering photometer to determine overall penetration is not greater than specific requirements set by system design needs and not greater than 0.05%. Testing can occur using other equally effective methods and equipment.

## H. How to Test PHEAF Equipment Using a Laser Particle Counter

As discussed above, the aerosol test method has some inherent problems in assessing PHEAF effectiveness. Further the aerosol particle method is extremely costly, requiring over \$15,000 of testing equipment and a trained operator. The laser particle counter method is low cost and relatively simple to use.

The International Atomic Energy Agency (IAEA) published their initial research on using laser particle counters to assess PHEAF effectiveness in 1985. They concluded that, "The laser detector has the great advantage that particles with different physical characteristics can be measured. The application of the laser detector to develop an inter-laboratory test method is well promising."

In another study of laser particle counters assessment of HEPA filters in 1996, W. Bergman, K. Wilson, J. Elliott, B. Bettencourt, J.W. Slawski,<sup>37</sup> of LLNL conducted research on a comparison of HEPA filter tests using DOP and laser particle counters. They presented their paper, "In Place HEPA Filter Penetration Test," at the 24<sup>th</sup> DOE/NRC Nuclear Air Cleaning & Treatment Conference in July 1996. <http://www.osti.gov/bridge/purl.cover.jsp?purl=/325065-sDUNq6/webviewable/> They concluded:

"The increased sensitivity of the laser particle counter allows filter penetration measurements of two stages of HEPA filters for both the leak test and the penetration test. This capability, which is not

possible for the standard photometer based leak test, is advantageous because of the reduced testing time and the difficulty in measuring the penetration of individual stages in systems having minimal space between stages.



## I. In-Field Method for Laser Particle Counter (LPC) Testing and Evaluation of PHEAF Equipment

### Particle Counting Size Range Options

Not all particle counters measure 5 or 6 particles size ranges. A number of inexpensive particle counters measure at the 1 micron size range and the 5 micron size range. These two ranges actually include particles from 0.3 microns to 3.0 microns and > 3 microns to 7.5 microns respectively.) Though it is preferred to validate a PHEAF device using at least a 5-size range particle counter, it may be possible to use a 2 size range particle counter, provided that one of the ranges includes 0.3 microns.

- 1) Set the particle counter to the differential counting mode. Do not use the cumulative counting mode.
- 2) Set the sampling period to no less than 20 seconds, 0.033 cubic foot or 1 liter sample volume. (A longer sampling period can be used, but it adds no statistical significance to the data.)
- 3) Before the PHEAF device is turned on, take three background particle count samples of the air approximately 1 foot in front of the intake to the PHEAF device making sure not to disturb the device and generate any particulates. The three sets of results for each particle size range should be recorded on the sampling sheet. The three sets of results are then averaged for each particle size range.

Note 1: A test room of at least 15' by 15' is recommended for testing a large, 2,000 cfm air filtration device to minimize the impact of the AFD on the background particulate levels during the testing process.

Note 2: In a dirty environment, a complication can occur when measuring the background particle counts. When the PHEAF equipment is turned on it can stir up dust and debris on the floor and significantly increase the background particle levels. If it is necessary to check PHEAF equipment performance in dirty environments, it would be best to place the device on a large, clean sheet of 6 mil polyethylene plastic approximately 6' x 6' and then turn on the PHEAF device to stabilize the background particle counts to some degree. If the background particle levels have increased significantly, the higher numbers should be used in the effectiveness calculations. In addition, it would be prudent to recheck the background particle counts after

measuring the discharge particle levels of the PHEAF device to make sure the background particle counts did not significantly change.

4) If more than one PHEAF device is to be tested in the same environment, the background air particle counts will need to be retested between each device. The operation of the PHEAF device may actually decrease the particle counts in the general area if operated for an extended period during testing.

Note : This reevaluation of background particulate concentrations is also necessary because some PHEAF devices may arrive on site after being used in remediation/abatement settings. Consequently, they may release particles into the test environment during the evaluation process. This will be especially significant if the PHEAF device fails the test.

5) Turn on the PHEAF device. The PHEAF device should then be operated at normal flow conditions for at least 1 minute prior to initiating testing. Note: If the device has 2 operation speeds (exhaust volumes), the unit should be tested at each operating speed using a separate test evaluation sheet for each speed. The operating speed being tested should be documented on the test form.

6) Prior to collecting the exhaust air sample, the sampling head of the particle counter should be placed in the center line area of the exhaust air stream, parallel to the discharge air direction. The probe should be no further from the exhaust than 1 diameter or the smallest dimension of the exhaust. The LPC operator should position their self downstream and away from the PHEAF device exhaust. This will minimize any risk of particles coming off the clothes or hands of the LPC test administrator and affecting the test results.

Note : If the discharge of a large AFD is within 10 feet of a wall, the high velocity discharge air stream can reflect off the wall can cause interference with the discharge air stream. In such a case, it is recommended to either move the AFD away from the wall or connect a piece of clean, flexible discharge duct to the AFD and measure the redirected discharge air in a more open area.

7) The three exhaust/discharge test results should then be recorded on the second page of LPC data collection form.

8) Calculate the average of the exhaust discharge particle counts for all measured particle size ranges. Record the averages in the table at the bottom of page 2 of the form and calculate the effectiveness at each particle size range using the equation provided.

9) Assign the PHEAF class for each particle size range based on the PHEAF Effectiveness Classes. The lowest class rating of the particle size ranges measured is the overall rating for the device.

## **SPECIAL PROCEDURES FOR VACUUM CLEANERS OR VERTICAL DISCHARGE UNITS**

PHEAF devices such as portable vacuum cleaners or bottom discharge devices can stir up particles from the surrounding air and entrain them in the exhaust air stream. These foreign particles make the exhaust air appear to be dirtier than it actually is.

When dealing with bottom discharge air filtration devices, if the LPC readings from the exhaust are greater than 1 digit, it is recommended that the device be placed on a new, clean sheet of 6 mil polyethylene plastic approximately 3' x 3'. In this way, the discharge air should not be disturbing any particles that may be present on the floor.

Note 1: Make sure the bottom of the air filtration device is clean.

Note 2: When dealing with some smaller vacuum cleaners, it is recommended that the device be visually clean on the outside and placed in a large plastic bag with the intake hose existing out of the top of the bag. The bag should then be sealed around the hose with duct tape or a similar technique. The device should then be turned on and a small slit cut in the bag so that the air exits the bag at a high velocity with the bag staying inflated. The head of the laser particle counter should then be placed into the opening so that it is parallel to the exhaust airflow. Samples can then be taken in the exhaust air stream and recorded as discussed above.

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# Overexposed

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**Abstract:** “Overexposed” will help enlighten and motivate safety professionals to search for solutions and alternatives to hydrogen sulfide exposure. Current developments and progress in oil and gas exploration, along with production, continue to expose employees to Hydrogen Sulfide. “Overexposed” discusses methods of collection, sampling, calculating radius of exposure, along with analysis to promote professional development of safety professionals.

The evolution of Oil and Gas production continues to be plagued with one common invisible enemy in the Permian Basin. This silent killer is hydrogen sulfide. Today the Permian Basin is producing over one million barrels of oil each day which is 20% of lower 48 states production. With these production numbers comes risk of injury for employees dedicated to Oil and Gas extraction. Although there is informed and known risk in the Oil and Gas, our employees continue to be exposed to hydrogen sulfide with little options for accurate and precise measurement of exposure, emergency response, and treatment.

Hydrogen Sulfide is a colorless, invisible gas which can be present in Oil and Gas production in the Permian Basin. The permissible exposure level for hydrogen sulfide is 10 ppm (according to NIOSH). The short term permissible exposure level for hydrogen sulfide is 15 ppm (according to NIOSH). Hydrogen Sulfide is immediately dangerous to life and health at 100 ppm. During the extraction of Oil and Gas many employees are at risk of exposure from drilling process to production this gas is a common enemy.

Determining if an invisible killer is present is not a task to be taken lightly, hydrogen sulfide measurement must be accurate and precise to ensure the safety of the employee. Poor sampling methods and lack of knowledge of interpretation of results can lead to overexposure of the oil field worker. Oil and Gas companies must ensure proper annual hazard assessment is conducted to evaluate the risk of each oil field employee. Many times this hazard assessment is conducted by inexperienced safety professionals which disregard the need for accuracy for assurance of employee safety. These failures lead to overexposure of the oil field employee to hydrogen sulfide.

After proper sampling methods have been conducted it is important to calculate the radius of exposure to protect co-workers, contractors, and communities. The radius of exposure is dependent on field data precision and accuracy to ensure well-being of staff and unsuspecting public. If the presence of hydrogen sulfide is detected, a contingency plan must be offered to ensure safety of all employees and communities. These emergency plans must be clearly communicated to all employees and public with complete disclosure by the Oil and Gas company in regards to exposure values.

In regards to emergency plans, according to ANSI Z390.1 (2017) recommendations it is encouraged to move crosswind and upwind away from source, note wind direction at all time for changes, and don appropriate respiratory protection if values exceed permissible exposure levels. Consistent and real-time monitoring must be ensured for safety of employee and public.

The treatment options for hydrogen sulfide have been limited in scope. First Responders need to evaluate victim for respiratory and cardiac issues. For many years the use of hyperbaric chambers has also been recommended for treatment of victims of hydrogen sulfide. Currently Twin Horse Environmental has begun a non-profit incentive called H2SOS to provide Oil and Gas workers with alternative treatment options for hydrogen sulfide exposures. The first phase of treatment shall

be provided to Oil and Gas employees to reduce the effects of hydrogen sulfide exposure at no cost to the employee. H2SOS will provide a neutralizing agent for exposed employees to help increase the chance of survival of the victim.

H2SOS is the first of its kind. With Oil and Gas production increase and the United States set to be number one oil producer in the world. The Permian Basin which is one of the most plentiful supply of oil carries the weight of a silent killer a risk of exposure to the employee. H2SOS is administered as an inhalant to exposed victim the chemical make-up of H2SOS reduces the hydrogen sulfide while initiating a hyper responsiveness.

H2SOS is the first step in post exposure to hydrogen sulfide. The need for additional first responder care is imperative. The first responder shall provide intermuscular treatment which blocks the dissociation of the cytochrome of the mitochondria. This is called H2SAVE. Along with H2SAVE and Oxygen shall be administered in an attempt to save the victims life after hydrogen sulfide exposure. H2SExChange is the final part of treatment model for exposed victims of hydrogen sulfide. The victim will have an exchange of H2S exposed blood for appropriately typed blood for the victim.

H2SOS is awaiting FDA approval for emergency treatment of known or suspected exposure to hydrogen sulfide. H2SOS is administer intranasal (IN). H2SOS has little to no effect on people who have not actually experienced an exposure to hydrogen sulfide. Equipped with the education and training provided by VIDA programs and Twin Horse Environmental, H2SOS can be administered by bystanders. Each employee is prescribed a kit consisting of inhalant and lifesaving instructions. Mortality benefit from H2SOS is currently being conducted. Existing evidence is being gathered focusing primarily on training and delivering H2SOS kits to people exposed to hydrogen sulfide via company based programs.

Prescribers and pharmacists need guidance on who should receive H2SOS rescue kits. One approach is to develop an overdose risk tool to help deliver H2SOS to people at risk for exposure. However, H2SOS should target people most likely to witness another's overexposure, in addition to focusing on individuals who are at risk themselves. Therefore, providing H2SOS to the Oil and Gas alliances of those identified to be high risk for overexposure might be especially efficient. It is Important to observe the social networks of people who work in the Oil and Gas who may not be interacting with company based H2SOS programs or health care personnel may not be identifying them as potential beneficiaries of H2SOS.

As safety professionals knowledge of exposure risk must be assessed, evaluated, and regulations must be applied to protect employees. Safety professionals must be motivated, show concern for employee safety, reach to knowledge, understand the risk and apply regulations. Note to All Safety Professionals: Be part of the solution!

# ROV Safety: Epidemiology, Risks, Hazards, Interventions, and Trends

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**Abstract:** Recreational off-road vehicles (ROVs) include all-terrain vehicles (ATVs) and utility terrain vehicles (UTVs). The ROVs are used by an estimated 35 million Americans for recreational and occupational applications. The majority of riders (78%) use these vehicles for blazing trails, camping, hunting and other recreation activities. The occupational uses are expanding from the farm and ranch to land management, search and rescue, police and fire, military, public administration, mining, retail, education services and more. These versatile vehicles are not without risks and adverse health outcomes. An estimated 400,000 users are injured annually with nearly 100,000 seeking medical care in emergency rooms across the country. Since 1982 the Consumer Product Safety Commission has investigated over 15,000 fatalities associated with ROV use. The major interventions to improve safety have included rider/driver training and education, design and engineering changes and legal strategies. The Specialty Vehicle Institute of America (SVIA) offers safety training through the ATV Safety Institute (ASI) to purchasers of ATVs and the Recreational Off-Highway Vehicle Association (ROHVA) for UTV buyers; unfortunately, only 10% of new owners engage the active learning opportunity. Consumers are more recently buying UTVs at twice the rate of ATVs for the design enhancements, added features and improved safety.

**Key Words:** All-terrain vehicle (ATV). Recreational off-road vehicle (ROV). Off-highway vehicle (OHV). Utility terrain vehicle (UTV). Side-by-Side.

## Introduction and Background

All-Terrain Vehicles (ATVs) arrived in the US during the early 1970s (GAO, 2010). The three-wheeled vehicles were quickly adapted for occupational uses in agriculture and became very popular with recreational riders. The original vehicles were uniquely designed with large, low pressure tires, straddle seats and equipped with motorcycle like handle bar steering and hand controls (GAO, 2010). Sales skyrocketed by the early 1980s accompanied by increasing injury and fatality among riders. The Consumer Product Safety Commission (CPSC) actively investigated the fatalities beginning in 1982 and brought pressure to bear on the manufacturers for improved safety designs. In 1988 the industry signed a settlement decree with the CPSC to stop sales of the three-wheeled vehicles in the US favoring the more stable four-wheeled vehicles used today (GAO, 2010). In addition to shifting sales to the safer four-wheeled vehicles, the Specialty Vehicle Institute of America (SVIA) created the ATV Safety Institute (ASI) to develop and provide safety materials and rider-active training for consumers. The ASI developed the five-hour, hands-on RiderCourse™ provided free of charge to all new vehicle purchasers.

In Australia, New Zealand, Sweden and other areas of the world, the four-wheeled vehicles were called quadbikes and have found significant popularity among agricultural industries as well as with recreational riders (Grzebieta, Rechnitzer, McIntosh, Mitchell, Patton, and Simmons, 2015). In more recent times global sales have continued to rise exceeding an estimated \$7 billion US in 2017 with expectations to double by 2025 (Allied Market Research, 2019). The ASI estimated that 35 million Americans used approximately 11 million ROVs (ASI, 2018). While sales have been strongest in the US market, global regions with active sales also include Latin American, Europe and Asia Pacific.

Recreational off-road vehicle uses have continued to expand serving a wide range of consumer needs and applications. The ROVs are used in agriculture, construction, manufacturing, police, search and rescue, utilities, mining, land management and more (Lagerstrom, Gilkey, Elenbaas, and Rosecrance, 2015). An estimated 22% of riders use ROVs for occupational purposes while 78% are seeking recreational enjoyment (ASI, 2018) such as exploring, trail riding, hunting, fishing, camping, racing and more (Finley, 2019; GAO, 2010). In recent years UTV style ROVs are being used and sold to both recreational and oc-

cupational users on a more frequent basis than the quadbike or ATV (Hartfiel, 2016).

The growing UTV popularity suggested that purchasers preferred the safer design and new features by a two to one margin (Allied Market Research, 2019; Hartfiel, 2016). The UTV, commonly called the side-by-side, may weigh up to 2,000 lbs (907 kg) with most ranging between 1200 – 1600 lbs (544 – 725 kg) (Huntley, 2019). The UTV is wider by design than the ATV with common width dimensions of 48 – 60 inches (121 – 152 cm) and may be up to 160 inches (406 cm) long. These vehicles have greater stability with distinctive design differences from ATVs that include bench or bucket seating, passenger seating, steering wheel, foot levers and controls as well as safety system features including seatbelts, roll cage and speed limits if the seat belt(s) is/are not fastened (Jepsen and Henwood, 2010). The SVIA through the ROHVA offers a five-hour, hands-on interactive course called DriverCourse™ similar to the ASI RiderCourse™.

## Selected ROV Research Epidemiology

The literature is rich with data on ROV related injury and fatality. The CPSC had investigated 15,250 ATV related deaths by December 2017 (CPSC, 2019). Fatalities peaked between 2005 through 2007 with more than 800 deaths per year. States with the greatest number of deaths included Texas, Pennsylvania, West Virginia, California and Kentucky (CPSC, 2019). Riders 16 years of age and older comprised the largest user group (83%) accounting for 69% of the injuries (Richards and Loder, 2018) and fatalities (CPSC, 2019). Children under 16 years make up approximately 17% of the riders but account for 31% of the injuries (Richards and Loder, 2018).

The CPSC estimated that more than 400,000 nonfatal injuries occurred annually resulting in approximately 100,000 emergency room visits (GAO, 2010). Major causes of fatal injuries included riding on paved roads, having a passenger, not wearing a helmet, vehicle rollover, collision, and alcohol use (Langstrom, Magzamen, Stallones, Gilkey and Rosecrance, 2016). Non-fatal injuries seen in emergency rooms included contusion and abrasion, fractures, lacerations, internal organ injury, sprains and strains (CSPC, 2019). Richards and Loder (2018) examined injury data from the National Electronic Injury Surveillance System (NEISS) between 2002 and 2015 and found that 1,862,342 emergency room visits had been reported associated with ROVs, with more than 25% diagnosed with fractures. The data also revealed that nearly 60% were un-helmeted and 75% male. Fractures were most common in the upper extremity followed by the low-



er extremity, spine, skull and face, with ribs and sternum least common. Fractures of the femur, hip or pelvis were most likely to be admitted to the hospital (Richards and Loder, 2018).

Canadian researchers reported that ROV related injury rates had increased 85.7% between 1990 and 2010 (Vanlaar, McAteer, Brown, Crain, McFaull and Hing, 2015). Alcohol was implicated in more than 50% of the injury events. Males were over represented at 89% and age groups 16-25 year and greater than 46 years were at higher risk for ROV related injury.

There exists particular interest for the safety of children under 16 years of age by many groups. That concern has caught the focus of research scientists and clinicians (Vanlaar, McAteer, Brown, Crain, McFaull and Hing, 2015). The GAO (2010) reported that 22% of fatalities were young riders < 16 years of age during the years 1999 through 2008.

The CPSC fatality databases 1985 through to 2009 were examined for details associated with ATV related pediatric fatality cases (Denning, Harland and Jennissen, 2014). The research team investigated 3,240 youth fatality cases and found significant related factors. Risk factors associated with fatal injuries among youth included being male, operating the ATV, no passenger, age less than six years, and lack of helmet use.

### Risks and Hazards

The CPSC has established that some inherent dangers are associated with ROVs (GAO, 2010). The major risks and hazards for loss of control events (LOCs) are associated with higher speeds, sharp turns, riding up hills, down hills or cross hills (Carman, Gillespie, Jones, Mackay, Wallis and Milosavljevic, 2010) carrying passengers (Jennissen, Harland, Wetjen, and Denning, 2016), altering the design of the vehicle (GAO, 2010), as well as using ROVs on paved roads (Denning, G., Harland, Ellis, and Jennissen, 2012). Using the incorrectly matched unit to the rider is also known risk factor. The majority of youth related injury and fatality are associated with adult sized ROVs (CPSC, 2019; Richards and Loder, 2018).

Lagerstrom, Magzamen, Stallones, Gilkey and Rosecrance (2016) examined over 1,200 fatality cases received from the CPSC and used the epidemiologic triad for their analysis. The agent, host and environment model was applied to evaluate major causes and variable interaction. Their analysis revealed the major agent factors were type of crash, diagnosis, and body part. The major type of crash was collision at 42.9% with ejection 37%. The leading diagnosis was internal injuries 65.1% and body part most likely to be injured was the head at 59.9%. The major host factors included gender, being male 84.6 %, ages 16 to 64 years 73.8%, driver 91%, not wearing a helmet 88.2%, and presence of alcohol 84.3%. The major environmental factors were season, region and crash location type. The most significant season was summer 39.6%, region was in the south 46.4% and the location was paved street surfaces 58.3%. One rider was most frequently involved 79.7% of the time and no other vehicle involved 85.4% of the time. Their analysis revealed the complex nature of ROV accidents and led to the conclusion that no single risk factor or hazard fully explained the fatality events (Lagerstrom, Magzamen, Stallones, Gilkey and Rosecrance, 2016).

Operators are more likely to have an optimal and safe experience when riding the ROV that is correctly matched to their size and abilities. The ATVs have been produced in three sizes. (1) for child use equipped with small motors of 50 cc to 90 cc engines weighing up to 300 lbs (136 kg), (2) for youth 14 years to adult equipped with 150 cc motors and weigh up to 350 lbs (159 kg), and (3) adult models that are equipped with motors up to 1,000 cc and weight up to 800 lbs (363 kg) (GAO, 2010). The smallest ATVs designed for youth with 50 cc motors are 31.5 inches (80 cm) wide and 48 inches (121 cm) long (Huntley, 2018). While the largest adult sized units 1000 cc ranged

from 84 to 95 inches (213 – 241 cm) long and 46 to 48 inches (116-121 cm) wide (Huntley, 2018) and may reach speeds of 80 mph (129 kph) (CPSC, 2019). The conclusion is that size does matter and youth should not ride adult sized vehicles (CPSC, 2019; GAO, 2010).

The newer UTVs are generally larger and heavier than their ATV or quadbike predecessors and most commonly range from 1200 to 2000 lbs (544 – 907 kg), are up to 60 inches (152 cm) in width and 160 inches (406 cm) long (Huntley, 2018). The added width and length gives the UTV design greater stability compared to the narrower ATV. The narrower ATVs with its elevated seat height plus the rider raises the center of gravity of the vehicle. The higher center of gravity makes the vehicle susceptible to roll over events caused by high lateral load transfer forces when turning sharply and/or operating on paved roads due to enhanced friction coefficient between the tire and road (Bouton, Roland, Benoit, and Berducat, 2008). The ROVs of both types were not designed for use on paved roads; yet, they have been allowed on many community roads in over 30 states (ASI, 2019; Consumer Federation of America (CFA), 2019; GAO, 2010).

The ROVs were, and are, designed for off road use (CFA, 2019; GAO, 2010). Rugged and irregular terrain presents a variety of hazards and risks that may include steep hills and valleys, changing elevation, restricted visibility, obstacles, gullies, sand, mud and water, as well as dynamic ranges of temperature from extreme cold to high heat. In addition to environmental factors the machines themselves are capable of creating high levels of noise that may cause noise induced hearing loss with extended and unprotected exposure (Milosavljevic, McBride, Bagheri, Vasiljev, Mani, Carman, and Rehn, 2011) as well as vibration related injuries (Milosavljevic, Bagheri, Vasiljev, McBride, and Rehn, 2012). In reality, very little is known about the dynamic interactive risk that is associated with ROVs (Neves, Brazile and Gilkey, 2018).

### Interventions

#### Rider/Driver Training

The major approach to ROV safety has focused on enhancing rider knowledge, skills and abilities to reduce operator error. The ASI has traditionally provided the most popular training and educational model for ATV safety driven by the CSPC settlement decree (GAO, 2010). The ROHVA provides an equivalent basic DriverCourse™ for UTV safe operation. The five-hour, hands-on RiderCourse™ provides interactive, real experiential training for ATV users. The parallel course from ROHVA follows a similar curriculum for the UTV users. The training curriculums include instruction on appropriate clothing, personal protective equipment, pre-ride check, starting, stopping, climbing up-hill, down-hill and across hill, managing obstacles, respecting the environment and obeying laws (SVIA, 2010). The ROHVA course includes additional skills such as backing up, safety tools, safety systems, unit dimensions, approach angle, departure angle, ramp angle, knowing your ROV drivetrain, rocky, muddy and/or sandy terrain, driving near trees and water crossings (ROHVA, 2017).

Additional education and training are available from a variety of consumer and educational organizations. One such example are ATV Tip Sheets developed from collaboration between the High Plains Inter-mountain Center for Agricultural Health and Safety (HICAHS) and the Montana State University Extension system (Lagerstrom, Hibiske, Gilkey, and Rosecrance, 2015). In this case study, the investigators worked with three rural communities in eastern MT to develop educational materials aimed at increasing awareness of risks and hazards associated with ATV use in agriculture. The Tip Sheets focused on safe operations of ATVs while performing common ranch and farm tasks such as herding/mustering cattle, mending fences, spraying weeds and for general transportation. Another project resulted in online training made available through a partnership with HICAHS and the Mountain and Plains Education and Research Center (MAP ERC, n.d.). Most recently the HICAHS supported the training and certification of six MT Weed Control Association members so that they

could train their pesticide applicators on the ROHVA BasicDriver™ course as well as offering training to other UTV users. Additional training is planned for the fall of 2019.

### Engineering

Engineering modifications for increased safety stalled in 2014 with failure of proposed CPSC standards intended to further protect drivers and occupants of UTVs (CPSC, 2014). This new standard included enhanced lateral stability and vehicle handling requirements that specified a minimum level of rollover resistance and required that the units exhibit sublimit understeer characteristics. In addition, the rule required occupant retention requirements that would limit ejection of driver and passengers. The ROV would be required to have a passive anti ejection system such as netting to prevent occupants from being thrown out of the ROV in the event of a rollover. The CPSC also proposed a lower maximum speed of 15 mph (24 kph) without seat belts fastened. In addition, the rule required that all decals, placards and safety information be clearly visible to users.

There was fierce opposition to the proposed 2014 rule from manufacturers, distributors and select user groups. The transition of ATVs from their original three-wheel design to four wheels and then to UTV has been entirely through engineering evolution (CPSC, 2014; GAO, 2010). The most significant advances were made in the creation of roll cages to ensure a survival space in the event of vehicle rollovers. The new UTVs are equipped with safety systems including seat belt restraints, passenger handholds and speed interlock if the seatbelts are not fastened (25 mph or 40 kph) in addition to rollover protection cage (ROHVA, 2017).

After market rollover protection devices (RPDs) or crush protection devices (CPDs) are available for ATVs such as the quadbar™ that may reduce fatality as much as 50% (Myers, 2016). Testing demonstrated the effectiveness of the CPDs through the creation of a survival space in the event of an ATV rollover (Myers, 2016). The quadbar and other CPDs are very popular in Australia and New Zealand and more recently have caught on in Canada (Neves, Brazile and Gilkey, 2018). Advocates for safety support the retrofitting of ATVs in the US through a rebate program similar to that offered in Australia (Meyer, 2016). In 2019, the Worksafe New Zealand Agency issued a policy clarification that clearly stated the expectation for ATV/quadbikes to be outfitted with CPDs (Worksafe NZ, 2019a). The implication being was that CPDs are required and that injury or fatality associated with quadbikes that had no devices opened employer/owner to resulting liability from accident (Worksafe NZ, 2019b).

### Laws

State laws may vary greatly between states, counties and cities (ASI, 2016). In 2017, 23 states allowed ROVs significant access to community roads (Friedman, 2017) and another 12 allow limited access (CFA, 2019). Some states required licensing of ROVs but did not allow them to be used on community roads (SVIA, 2016). Other states license them similar to cars and trucks, allow limited or full access to community roads, and require a driver's license and/or safety certificate for operators (CFA, 2019; Huntley, 2019). Access privileges may be controlled at county or municipal levels. Many communities have allowed access based upon citizen requests despite the warnings from experts and safety coalitions (Weintraub and Best, 2014; Freidman, 2017).

Some states required helmet use for youth but not adults, restrict night use, required age limits for operators, prohibited passenger transport, ROV classification based upon size, weight and/or motor displacement and other parameters (ASI, 2016). For example, Wyoming had minimal regulation pertaining to ROVs limiting operation on community roads but allowed exception for the agricultural sector (ASI, 2016). Whereas, California had requirements for registration with the Department of Motor Vehicles, operator age limit of greater than 14 years unless supervised by an adult or rider holds a safety

certificate and is restricted from night use, limited noise levels, helmet requirements on public lands, no passenger transport unless the unit is designed for more than one rider, and prohibits operation on paved roads riding unless crossing the roadway. Montana law required that ROVs are registered and licensed similar to automobiles and trucks and may share the roadways in most communities. Noise levels must be reduced to below 96 dBA and vehicles must be equipped with spark arrestors (Huntley, 2019). Operators may include children ages 12 to 16 years that possess a safety certificate. Between 2004 and 2014 the number of states allowed some access to roads increased by 26% from 22 to 35 states. The trend for increasing access to paved roads continues and is predominately delegated to local communities (Weintraub and Best, 2014).

### Discussion and Conclusion

The retail market trends suggest that ROVs are expanding in popularity both nationally and internationally (Allied Market Research, 2019). Both types of ROVs have found increased uses for occupational purposes due to their cost efficient applications (Lagerstrom, Gilkey, Elenbaas, and Rosecrance, 2015). When conducting research in Montana with ranchers, they were quick to state, the ATV was less expensive than a pickup truck and less hassle than a horse and, thus were overtaking activities commonly performed on horseback (Lagerstrom, Hibeske, Gilkey and Rosecrance, 2015). Recreational use continues to be the major application for many users with 78% of riders and drivers seeking a fun time blazing trails, exploring countryside, camping, racing and more (ASI, 2018).

The major approach to ROV safety continues to be training and education of the rider and/or driver (Neves, Brazile and Gilkey, 2018). The industry sponsored basic RiderCourse and DriverCourse are the current models believed to make a difference in reducing risks through enhanced rider and driver knowledge, skills and abilities. The hands-on nature of both courses provides interactive and kinesthetic learning. Vehicle operators quickly learn that their decisions and actions may significantly increase or decrease their risk for loss of control events and related injury. Further research is needed to determine effectiveness of training and education (Neves, Brazile and Gilkey, 2018)

While engineering advances brought the once three-wheeled vehicle to four, the newest UTV design resembles the jeep or auto with bench or bucket seats, steering wheel, foot controls and integrated safety systems. The UTV style ROV is out selling the quadbikes/ATVs by a two to one margin (Allied Market Research, 2019; Hartfiel, 2016). Users are demonstrating their preference for the wider, more stable vehicles with roll cage protection and complete safety systems that are built into the vehicle. Data is being gathered from many sources that appear to validate the added safety of UTVs over ATVs with an estimated fatality ratio of approximately 1:4 (CFA, 2019; CPSC, 2019). One might conclude the UTVs are four times safer than ATVs or quadbikes but, the data are yet to provide the convincing evidence. Investigations to evaluate vehicle crashworthiness supports this assertion (Grzebieta, Rechnitzer, McIntosh, Mitchell, Patton, Simmons, 2015) and continues.

A great deal of high quality research on ROV safety has been performed in Australia and New Zealand leading to a novel system for vehicle rating ROVs based upon their intended use (Grzebieta, Rechnitzer, McIntosh, Mitchell, Patton, Simmons, 2015). The ATV or quadbike and UTV or side-by-side, "Vehicle Star Rating" (VSR) system, was developed by scientists and engineers working in the Transport And Road Safety (TARS) research center at the University of New South Wales. The research team crash tested ROVs under various conditions to assess the probability for operator survival. The team reported that, "The Star Rating system is intended to provide 'a safety rating' in that vehicles with higher star ratings will represent a lower risk of rollover and subsequent potential injury in the event of a rollover incident in the workplace environment based on the best currently available information" (Grzebieta, Rechnitzer, McIntosh, Mitchell,

Patton, and Simmons, 2015, page 3). The VSR assigned 0 – 5 stars based upon the following criteria (Grzebieta, Rechnitzer, McIntosh, Mitchell, Patton, and Simmons, 2015, page 5-26):

“Zero Stars: No survival space, high impact forces in rollover tests, high static load and difficult to displace vehicle manually. Score based on an initial static measurement of survival space and decision regarding laboratory rollover tests based on available survival space and vehicle mass.

One Star: A defined survival space, reduced impact forces in rollover tests compared to zero star, static load that can be tolerated for longer period and ability of specified proportion of population to displace vehicle manually. Score based on measurement of survival space and dynamic impact forces no Anthropomorphic Test Device (ATD).

Two Stars: More improvement in measures of survival space, impact forces, static load and manual displacement of vehicle. This might represent the limit for quadbikes in their current form. A quadbike with some form of ‘crush or operator protection device (CPD/OPD)’ might achieve a two star rating.

Three Stars: For vehicles with a CPDs meeting an agreed standard (which assesses strength) plus three point seat belts and a suitable internal survival space may be awarded three stars through inspection and static measurements. This would most likely apply to a side-by-side vehicle with CPDs.

Four Stars: A three star vehicle could be submitted for rating to four or five stars. Additional star rating would be achieved through a specified performance with respect to ATD parameters and ATD containment in frontal and side sled tests.

Five Stars: The five star vehicle offers superior performance in sled tests with respect to four stars and might include an inversion test”.

Creators of the VSR strived to reduce ROV related injury and fatality by properly classifying vehicle safety based upon intended use. The VSR applies to both the workplace and recreational environments thus increasing the number of informed consumer choices in the selection of appropriate vehicles for a user’s job or recreational needs. The TARS team also believes that the VSR will create competition among vehicle manufacturers to improve safety design and seek higher ratings through enhanced design and technological changes and reduce the training and education burden currently on the operator. The VSR system may impact policy makers internationally and in the US to strengthen the ‘fit for use’ concept with laws that dictate vehicle selection based on matching riders/drivers, safety features with intended use.

The ROV legal landscape has been changing in favor of increased access to public lands, private property and community roadways (CFA, 2019; Weintraub and Best, 2014). The US allows states, counties and municipalities the right to decide if ROVs are welcome on roadways. Laws vary greatly between and even within states and must be evaluated frequently for change. Living in MT, this author has observed ROVs on community roads daily in contrast to most California cities that restrict ROV use to off-highway use only.

The SPVIA is a strong industry and user group supported organization that fights to preserve and expand the rights of ROV owners and users at all costs. While epidemiologists, injury specialists, clinicians, academics and survivor groups fight to strengthen restrictions on use, the battle seems to show little success in blocking expansion to roadways. The most effective laws have been aimed at protecting youth < 16 years of age. The future is certain to reveal more data on injury and fatality experience and market reaction to choices and applications. The potential impact of the VSR has many excited for a universal system that may enhance safety for all ROV users.

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## Safety Incorporated into Emergency Response

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**Abstract:** Safety has been incorporated in Emergency Response Operations for many years, however emergency response personnel die in the call of duty every year by going into volatile situations and placing themselves in harm's way.

By investigating specific cases and the corrective actions taken, this presentation will disseminate the hazards and how those hazards are mitigated.

Every day, emergency responders risk their lives responding to unknown and possibly dangerous situations. How do they continually do this day after day? What is there in place to protect our emergency responders? How does Safety factor in when emergency responders go out on calls?

My experience has been in three areas, police, fire, and radiological response. Early in life, I worked with the police and then fire departments. Ranging from patrol, to investigations, to driving a fire engine, to being a hazardous material specialist for a city fire department. In the latter part of my career I have worked as an Environmental Safety & Health Specialist for personnel who respond to radiological emergencies. This paper will address safety components to each group and similarities between them.

Let's begin with the police department. They are normally the first ones on the scene. I once heard a term from another responder that denoted the police as "blue canaries". Blue canary is defined as "an emergency worker (especially a police officer or first responder) whose death alerts other personnel to a hazardous situation". I think in this day and age that term is not accurate in describing the Police or any other emergency responder. The amount of information police have on hand is extensive. Let's take, for example, each officer has a tablet readily available in each vehicle. This information can detail the location, name of the establishment, the type of material there, the name of the individuals, the warrants, etc. This is the age of information. Information can forewarn an officer of the hazards that may

be present. Also with the age of the information the equipment has advanced. Within the police department today you have highly trained personnel. In fact the training is extensive for recruits. The training facility is a large warehouse with store fronts and apartments, etc. There is reality based training and virtual reality training. There are pre-loaded scenarios so that even an experienced police officer can come in, choose, and perform. These scenarios place the police officer in a situation that he/she has to access the situation, prepare for, and act on. This aids them to encompass safety while still responding to an emergency. This facility can also be used by other local police and fire departments. Note: The training they receive includes defensive tactics, weaponry (80 hours) and Emergency Vehicle Operations (EVO) (40 hours) training.

Recruits after the academy actually receive 180 days of training being observed by training officers. This is a three phase process with the new officer learning/becoming more familiar with different areas of the city throughout those 180 days. Each phase has a new officer with an experienced officer/training officer with him or shadowing him.

Police officers are issued Gas Masks, Riot Helmets, a radio with holster, tasers, uniforms, batons, handcuffs, and pepper spray. Police officers supply their own gun, flashlight, tourniquet holder, gun holsters, kevlar vests and self-provided ice chest. Note within the police car they have a trauma kit, flares, fire extinguisher, radio that has an emergency button/open microphone, tablets-emergency/GPS, GPRS

and a car radio. Metro also has access to the All-Hazard Regional Multi-agency Operations Team.

In 2005 The Las Vegas Metropolitan Department (Metro) created an All-Hazard Regional Multi-agency Operations and Response Team – better known as ARMOR. This task force brings law enforcement agencies across Southern Nevada – including the Las Vegas, North Las Vegas and Henderson Police and the Nevada Department of Public Safety – to detect, mitigate and investigate chemical, biological, radiological, nuclear and explosive incidents. (Las Vegas Review Journal, August 10, 2019). As a matter of fact the ARMOR Team met with Brazilian officials prior to the 2014 World Cup to help them create their own unit. This team has an army of supporting robots/cyborgs. Their team brings unique set of skills and knowledge to the table, from a tech person, to tactical expertise, including scientific. Detectors can be placed on the robots. Robots can be small or large i.e., a Remotec Wolverine, a military –grade tactical robot that can be sent in dangerous situation. The smaller ones can fit down an aisle of an airplane and be used to communicate with barricaded suspects during a crisis negotiation while the unit's largest robot can pick up explosive or knock down a wall. The new technology has allowed this team to do things safer.

Let's move on to the Fire Departments. I interviewed the Fire Chief Brian Dees of the NNSS Fire Department. In Fire Chief's Dees words, fire personnel have a certain mindset on safety. They know they go in fire situations and other situations that could cost them their lives. Therefore precautions are always taken. Information is vital when they respond.

Once again there are computers/tablets in the Fire Response Vehicles. Information is available in regards to chemicals, chemical hazards, and quantity for Firefighters. In cities around the United States, businesses are required to supply this information to the local fire department who place it on their tables/computers for ready use when responding. Along with this information fire inspections aid in identifying facilities entries/exits, evacuation areas, and fire systems as well as having the blueprints. Technology has increased fire department's knowledge when going into a fire and/or accident situation.

The equipment on the fire response vehicles ensure the safety of the personnel, Self-Contained Breathing Apparatus (SCBA), firefighting equipment, and appropriate turn-out gear. Also they have Haz Mat Crews and a Haz Mat truck, with specialized equipment, detectors/instrumentation, and specialized PPE to go into chemical fires, and other hazards. Some fire departments have access to Unmanned Aerial Systems (UAS) and aircraft to determine the shape and characteristics of the fire. In some cases they use aircraft to place water on the fire to aid them in putting out the fire and identifying what type of fire it is.

A Safety Officer is always designated at each event. The safety officer for the NNSS fire department could be a Sr. Engineer and/or Captain that has been trained to be a Safety Officer. Their mission is to have the firefighters perform the job as safely as they can and to ensure each firefighter safety and health comes first.

The firefighters train continually throughout the year. It is extensive training and they are provided exercise scenarios to demonstrate capabilities. They also train with other agencies such as Las Vegas Fire Department, Henderson Fire Department, Clark County Fire Department and nearby Armargosa Valley Fire Department. Their main goal is to stay focused and be prepared to go at any time.

Radiological responders getting a callout is a little different than the Police and Fire department. They can go anywhere in the United States or the world. When a call out is initiated for a radiological response, the radiological responders have four hours until wheels up. Simply put means that the equipment and the responders will be in the air or on the road to the location within this time. Department of Energy (DOE) notifies the Radiological Responders and the Radiological Responders will work with DOE, police, fire, city/county/state/federal government agencies/countries that have the radiological emergency. They too require information on the type of radiation, where, what dosage, what is needed, in other words, who, what, when, where, why, and how. Once again with the age of information, the responders have information readily available to them on radiological/radiation material. They have equipment such as radiological detectors, tents, PPE, etc. already crated up and ready to go. They too will go into unknown situations but like the other two organizations their technology, equipment, and information available to them has vastly improved.

For technology and equipment, the detection equipment is smaller and much more sensitive. There has been experimentation with small Unmanned Aerial Systems (sUAS) and use of detectors. Emergency responders already use aircraft, helicopters or fixed wings, to carry the detectors. Through the use of computers, data on every part of the world is available. When working with certain agencies they are identified with vests and in some cases, Kevlar vests (especially in today's environment).

The principles they abide to and adhere to keep them SAFE. The term ALARA is not casually used. ALARA stands for As Low as Reasonably Achievable. ALARA is an approach to radiation safety that strives to manage and control doses to the work force and general public. The combination of engineered controls and administrative control procedures shall provide that exposure level as at ALARA. Engineered controls such as the use of shielding; i.e. lead bricks, portable shielding and facility shield walls and doors; are effective in reducing external exposures to personnel. Use of ventilation systems and containment devices are engineered controls to reduce internal exposure to radioactive material. Administrative controls can be as simple as time and distance. The less time in a field of radiation and staying as far away as possible from the radiation source will reduce the external exposures. Postings are used to prevent access to areas with either a radiation or contamination hazard. Dose limits and established perimeters are maintained. Protective measures such as protective clothing as well as respirator are used to protect the employee.

All three organizations have a framework of Safety! They have a mindset. They know they may be going into unknown situations, unknown circumstances, but all three prepare and preplan. The personnel are educated and trained. Each organization has increased in knowledge and procedures in their respective areas, from biological, to chemicals to radiological and much more. They train with respective agencies and learn from each other. Each organization maintains and provide tools that make them be safer in their respective positions. Whether it be using robots versus personnel, aircraft for putting out fires and or sUAS for detection they are ensuring the safety of the responders.

Prior to any response, police, fire, and/or radiological, the hazards are discussed and a plan of action is taken if given time. With the ready communication available to each group it is easy to call for assistance and/or get information. At one time emergency responders might have been called blue canaries but not in this day and age.



# Is Education and Training Required for Workplace Safety?

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**Abstract:** This presentation examines why there is a need to provide occupational safety and health education and training. The history of workplace health and safety education and training is traced through British legislation, the International Labour Organisation (ILO), and through Australian law. Case studies and examples of what is currently included in work related safety and health education for children, people in the workplace, for the public, and the benefits of this education are included.

## INTRODUCTION

With the many technological inventions used in industry there is an increasing need for employee work related education and training to be able to do the work safely. Many accidents occur when people are new to a workplace if education is not provided on how to work safely (1). The following is an example from Australia. As part of giving public service and helping the next generation to learn about working in industry a 15 year old college student was provided with work experience at Tho Services Limited. This student was given a visitors induction at the workplace. The work that the student was asked to do was welding, but he was not given any education or training on how to wear the supplied welding helmet or told about the need to pull down the eye protection visor to protect his eyes while he was welding, so he did the welding with no eye protection. This resulted in the work experience student receiving flash burns to his eyes and losing part of his vision permanently in both eyes (2)(3).

The student now requires visual aids for the rest of his life, he cannot play football or cricket which he previously enjoyed doing as he now cannot see the ball, his future employment prospects are limited and his quality of life is decreased. The employing company was fined \$240,000 by SafeWork New South Wales for breaching section 32/19 (1) of the Work Health and Safety Act 2011. The company owners could not pay this amount so the company went into liquidation and all employees lost their job at this company (2)(3).

This case study highlights some of the reasons that education and training are a pre-requisite for knowing how to work safely. In this case the lack of safety education for a work experience student affected a small number of people. A case where lack of training and education affected the safety of a larger number of people was the Bhopal Methyl Isocyanate (MIC) Pesticide Plant disaster in India on the night of the 2<sup>nd</sup> to the 3<sup>rd</sup> of December in 1984.

## WHO NEEDS THE EDUCATION & TRAINING?

The following story of the Bhopal disaster illustrates that everyone who is employed by the company at the workplace, and also people in government and the community, need education related to workplace safety.

In 1975 plant operators at the Union Carbide India Bhopal Methyl Isocyanate Plant had received an average of 18 months safety and work related education and training on how to operate the plant safely. Over the subsequent years the amount of work related education and training that the plant operators received had decreased to less than a month per person by November 1984 (4). In 1981, after the technical experts from the United States of America left this Union Carbide Plant because the plant was not making a profit, there was very little work related training and education provided for employees (5). In 1984 the remaining plant operators had been trained to use storage tanks that were later modified, but no training was provided to the plant employees on the use of the modified tanks (6). This highlights the need for ongoing employee education, particularly

when there are work related changes. On the 3<sup>rd</sup> of December 1984 the work supervisor ordered the washing with water of the 4 lines to the MIC tank as the tank was not pressurising and the lines were blocked with rust and solid sodium salts (4). The supervisor had only worked in the area for one month and had just been given the maintenance responsibilities. To save money the company had eliminated the position of maintenance supervisor (6). The workplace supervisor did not understand the plant operations, had not been told how the equipment at the plant operated or the correct way to do the equipment maintenance. The operator who was washing the lines was a new worker. He did not know that he needed to put a slip blind into the pipe so that the water would not go into the MIC storage tank and cause a chemical reaction (5)(6). This highlights the need for work related safety education and training for new employee at a company and for employees who are new to an area of work.

When there was a build-up of pressure in the MIC tank due to an exothermic reaction with the water that entered the tank due to the line clearing workers could smell MIC in the air, but chose to ignore this as they did not know what to do (6). An hour later there was a massive explosion. The situation was made worse in that none of the fire and rescue squad members were trained or qualified to deal with this type of accident (4).

There was also lack of community safety education about the Bhopal Union Carbide plant and its products. The Government allowed the Union Carbide Bhopal plant to be placed in a residential area and for members of the general population to live in large settlements close to the plant when this plant was manufacturing MIC based pesticides as members of the government did not understand the dangers of this decision. The general population also did not know the dangers of living close to this major hazard facility (5). This highlights the need for education related to major hazard facilities to be provided to decision makers in government and to the general population.

Following the explosion at the Bhopal Union Carbide plant the company Medical Officer told the Director General of Police and the Mayor of Bhopal that the MIC gas was only a minor irritant and that there was no antidote (7). In contrast Professor Gehlawat, who was present in Bhopal at the time, knew that the gas was heavier than air and that he needed to stay inside his hotel room to avoid exposure to this gas. He told all of the hotel guests to '(1) shift to the top floor, (ii) to close all of the windows, (iii) to switch on the ceiling fans and exhaust fans, (iv) to breathe through wet napkins and (v) to wash eyes with water as frequently as possible' (8, p.261-262). Gehlawat knew that milk was an antidote to the gas as casein and other substances in milk absorb toxic substances, minimise entry into the blood stream and minimise the effects on other body systems, so he asked the hotel manager to give milk to all of the hotel guests. He had studied the effects of chemicals for many years so knew what to do to assist with chemical injury mitigation (8).

At a temperature of 200<sup>D</sup> C (which the MIC did reach) it forms a gas that contains hydrogen cyanide (HCN). The Medical Officer did not know this. The antidote to HCN is sodium thiosulfate which was given to some of the exposed victims and saved their life (9). A German toxicologist came to Bhopal with 50,000 injectable vials of sodium thiosulphate, but was asked by the Government to leave Bhopal and not to provide the antidote to gas exposed people (57). The above information, if provided by the Union Carbide Medical Officer to the authorities, could have saved the lives of many of the people who died and would have given authority to the government to allow the provision of the antidote to the people who required it.

The Bhopal plant workers knew to stay indoors and none of these workers died due to the effects of the gas from the explosion. However, as a result of this accident there was the immediate death of 3,787 people in the streets of Bhopal. Trees in the path of the gas lost all of their leaves and many animals died, particularly cattle. The problem of disposing of the dead human and animal bodies became an environmental health problem (7). A further 3,000 people died within a week (official government figures. Other estimations were that 30,000 people died within a week). The Indian Government has recorded that 47,787 people subsequently died as a result of their exposure to the toxic gas (81,574 government recorded deaths) and 558,125 people were injured with, in some cases, severe and disabling injuries (8)(9)(10)(11)(35). In 2003 compensation was awarded by Union Carbide to 554,895 people who had permanent severe disabling injuries as a result of their gas exposure on the night of the plant explosion and to 15,310 families where a family member was killed by the gas but at least one other family member survived (9).

The high number of deaths and permanent disabling injuries was, in part, due to insufficient employee education and work related training, to the lack of knowledge of the company medical officer, to lack of government knowledge about plant related safety, and due to lack of knowledge by the general population of the effects of the products manufactured at the Union Carbide Plant in Bhopal.

This disaster shows that for people to know how to work safely and to understand the dangers in a workplace there should be relevant education for everyone who has decision making and that employees and their supervisors need to be trained in how to perform their work correctly and safely.

Oxford Dictionaries (12, p.1) define education as 'the process of receiving or giving systematic instruction'. Business Dictionary (13, p.1) record that training is an 'organized activity aimed at imparting information and/or instructions to improve the recipient's performance or to help him or her attain a required level of knowledge or skill.' Much of the work related education may be provided through educational institutions, such as the formal degree qualification for a medical practitioner, while the training would be more likely to be provided by people at the workplace, such as instructions by a supervisor to an employee on how to put a slip ring into a pipe and an explanation of why this is required to have a safe work process.

#### **HISTORY OF WORK RELATED EDUCATION & TRAINING.**

In the early years (before the industrial revolution) parents and tribe members provided training to their children on how to hunt, gather and later to do farm and other work so that the children did not get sick, injured or killed while working. The most common education and training method used was buddying up an inexperienced worker with an experienced worker so that the experienced person could explain how to do tasks to the learner. In this situation there was individual training and the education provided depended on the knowledge level of the trainer.

Then came the industrial revolution with machinery that could be dangerous to operate, the use of chemicals and other substances that could harm human health, more complicated work processes and the employment of people (employees) for long hours for wages. These

workers were employed to make money for factory owners. Many factory owners were just interested in producing products for profit and did not consider their employees work related safety and health. Employees were just part of the production process. Employee collective power was weak at the beginning of the industrial revolution as most employees just wanted to have a wage to be able to support their family. Factory owners provided very little employee work related education.

Working conditions in the 1700s were difficult and often unhealthy in Britain. The first introduced safety and health legislation related to stopping very young children from working. This legislation was the 1788 Chimney Sweepers Act that was based on Dr Percival Potts's 1775 cancer research. Boys as young as four were being used as chimney sweeps. The chimneys were usually 9 by 9 inches wide so a small person was required to clean them. This Act stated that no boy should be bound as an apprentice before he was eight years old. His parents' consent must be obtained for the child to be employed as a chimney sweep, the master sweep must promise to provide suitable clothing and living conditions, as well as an opportunity to attend church on Sundays (14).

In 1882 morals was in the title of the Health and Morals of Apprentices Act introduced by Sir Robert Peel because, once a month, the apprentices were required to attend a religious service to receive moral education. Apprentices were to be prepared for confirmation in the Church of England and must be examined on their religious knowledge by a clergyman at least once a year. Male and female apprentices were to sleep separately and not more than two per bed. Apart from when they attended church and were working in the mill children were locked into their upstairs (above the mill) accommodation. Child apprentices were from poor families and were bound and unpaid until they turned 21 years old. Most of the children working in the mills were between 5 and 8 years old and worked 13 or more hours a day. The local magistrates had to appoint two inspectors known as visitors to ensure that factories and mills were complying with this Act. One inspector was to be a clergyman and the other a Justice of the Peace. These were the 1st workplace inspectors and were unpaid. Very little work related education or training was provided to employees in the 1800s in Britain. Under this Act there was more focus on religious education than work related education and many children died from work related causes (15).

In Germany in 1871 Chancellor Otto von Bismarck introduced the Employers' Liability Law. At this time in Britain workers were covered by Common Law. Under common law if a worker could be found in any way responsible (contributory negligence) for a work related injury, such as the employee slipped on a workplace floor and broke his or her arm, then it was the employee's fault and no compensation could be claimed by the employee. There was a culture of blaming the victim for their work related injury, ill health or death. If the injury resulted in part from any action, or inaction, of a fellow employee then, under the fellow servant rule the employer was not responsible. To ensure that the employer had no responsibility for any work related injury or ill health when an employee signed a contract of employment then the assumption of risks of harm from doing the work was formalised in many workplaces with the employee abdicating all rights to sue to obtain payment for any work related injury or illness. This was 'known as the "worker's right to die," or "death contracts"' (16, p. 106).

Following the introduction of the Employers' Liability Law in Germany in 1880 the British Parliament passed the Employers' Liability Act. This was the first British legislation in which employers would be required to pay workers' compensation if the accident was caused by the negligence of a manager. It also abolished the 'assumption of risk' that employees previously took when they accepted employment. As there was now a financial consequence for work related injuries that could be traced back to employer management of the work, employers began to provide employee work related training. However acci-

dents were considered by many employers as the results of poorly motivated employees not paying attention to what they were doing. Safety education was a matter of telling people to be more alert (17).

In the United States of America many employees were injured, died or developed black lung disease (pneumonconiosis) when working in the coal mining industry. In an effort to improve coal mine safety in 1864 the Pennsylvania Mine Safety Act was brought into law. This was the first workplace safety law in the United States of America and, to cover employers against paying for employee work related injuries, ill-health or a work related death at the same time the first insurance policy was issued in the United States of America. However it was not until 1970 when President Nixon signed into law the Occupational Safety & Health Act that legislation in the United States of America required employers to provide employees with education and training to safely do their work (18).

In Australia 1800 to 1911 was the era of social legislation in which Australia had its first occupational safety, health, welfare and workers' compensation laws passed and enforced by the government. 1911 to 1959 was the inspection era in which safety inspectors targeted checking guarding, housekeeping and physical conditions. Before the 1970s occupational safety and health legislation in Australia was prescriptive, detailed and hazard specific. Safety was seen as the responsibility of government inspectors. Safety Performance was measured by disabling injuries and employees were not required to have occupational safety education.

In Britain, in 1972, Lord Robens submitted a report on occupational safety and health legislation with recommendations to change from having specific requirements to having a general duty of care which applied to everyone who could affect, or be affected by, workplace safety, including the employer, employees, manufacturers, installers, suppliers of goods and services, to ensure that the workplace, work processes, goods and services were safe and healthy for everyone who came on to the workplace, conducted work processes, and/or who could be affected by the work, goods or services provided (19) (20)(21)(22).

As well as the Robens report findings being the foundation of new British occupational safety and health legislation these findings were taken by the International Labour Organisation (ILO) and were published as ILO Convention 155, Occupational safety and health and the working environment. This Convention was ratified by many countries. When an ILO Convention is ratified by a country's government it forms the foundation of the country's law related to what was ratified. One of the countries who ratified ILO Convention 155 was Australia, so the Robens philosophy was incorporated into Australian occupational safety and health law.

As part of the Robens philosophy, which became law in Australia, employers had a responsibility to 'provide such information, instruction, training and supervision of the employees as is necessary to enable them to perform their work in such a manner that they are not exposed to hazards' [Occupational Safety and Health Act, Western Australia 1981, s19(b)]. To meet these requirements the employer had to provide all employees with instruction, training and work related education related to being able to complete their work safely. To check if this was actually happening in industry in 2019 the author asked people who were working in industry if they had received this work related education. Following are two replies.

*"As for my call centre experiences regarding health and safety education all I can say is that the safety person always comes in during the induction, tells you that his door is always open but you quickly learn when you hit the floor that if you want to learn anything about your workplace safety or health or have any complaints and you raise them with your supervisor (who is on a temporary contract also) they won't raise them as they are worried about their job and if you raise any issues or ask for work related safety education then you will find your*

*contract not being renewed at the end of the 3 month period. I guess the main point I was trying to make is that in this society we have such an enriched outsourcing environment where everyone is so worried about their job that they do not spend any time, apart from one orientation lecture, on safety education, employees are afraid to bring up safety issues and these sort of companies prime focus is on making money; not its employees safety education and well-being."*

In this case, although there is a requirement for education and training, the employee feels that, apart from in an orientation lecture, the legal requirements are not being met. In general, in Australia, if an industry is perceived as not being dangerous employees would receive a safety induction and an emergency procedures presentation. In industries where there are more perceived hazards safety education may be given on a daily basis. The following survey reply is related to one such industry.

*"In Western Australia mining used to be one of the most unsafe industries, but this has changed dramatically and it is now one of the safest industries in the world."*

### THE WESTERN AUSTRALIAN MINING INDUSTRY

The path for the Western Australian mining industry to being one of the safest industries goes back, in part, to the implementation of the Robens Report recommendations into workplace safety and health legislation. In the United Kingdom (UK) in the Coal Mine Regulation Act 1872, there was a provision for mine workers to be involved in inspecting the mine in which they were working to ensure that it was safe. These employees were called Check Inspectors. Lord Robens saw how effective these Check Inspectors were in improving workplace safety and health so he included in his report employee involvement in workplace safety and health.

After the Australian Government ratified the ILO Convention 155 Western Australian mining industry safety and health representatives came into existence in 1995 with the implementation of the Mine Safety Inspection Act 1994. Safety and Health Representatives were employees who were elected by their peers to represent people in their work area on workplace safety and health matters.

Under this law safety and health representatives are legally required to attend a 5 day course to learn how to identify, assess and apply risk management processes to workplace hazards; how to conduct workplace inspections and investigations, apply health & safety legislation, communicate information on safety and health matters in their workplace, how to resolve conflict and issue Provisional Improvement Notices. Safety and Health Representatives are also encouraged to continue to attend other courses to update and improve their occupational safety and health knowledge. The knowledge that these employees gain through this education is then used to improve workplace safety and health.

In Western Australia, under the Mine Safety and Inspection Act 1994 and under the and Geothermal Energy Safety Levies Act 2001 a levy is collected from the mining companies and from major hazard facility companies to pay for costs associated with administering and enforcing safety laws. In 2015-2016 the levy collected was \$25,160,000. The mining inspectors, as well ensuring legislation compliance engage with managers and other mining industry employees to provide education related to improving company risk management (23).

To be a Western Australian mining inspector the employment requirements are to have a Bachelor of Science or other approved Bachelor degree in an occupational health and safety discipline relevant to the resources industry. Qualifications or training in occupational hygiene, noise, environmental health, radiation, ventilation qualification or training in risk management or a related discipline are considered favourably. Demonstrated knowledge and experience of the practical application of occupational safety and health legislation and risk management principles within the resources sector is essential. Experi-

ence and skills in investigations managing emerging issues, changes and projects is required. Demonstrated ability to listen, understand and adapt to communication style and message to suit a range of audiences including the ability to negotiate effectively and convey information and structures via written and oral communication is important. Once employed there is also ongoing safety education for Inspectors to keep them up to date with work related knowledge.

As a summary these inspectors need to have completed formal tertiary education qualifications to have the knowledge to do their work, but they need more than this. They also are required to have good communication skills to enable the people who work in the Western Australian mining industry to learn from their expert safety knowledge. One of the outcomes of the work of the inspectors in sharing their work related safety knowledge is an improvement in the safety practices in the Western Australian mining industry. In Western Australia, in 1900, there were 45 fatal accidents reported. This was a fatality rate of 20% (24). In the year 2012 there were no fatalities in the Western Australian mining industry (25). In 2015-2016 there were four fatal accidents from an average work force of 102,343 workers. This is a fatality rate of 0.0039%. While this fatality rate is low the aim is always to have no fatalities as was the case with the Western Australian mining industry exploration workers (2,223 workers with no fatalities) in 2015-2016 (26).

Managers and many other employees who work in the Western Australian mining industry have formal work related education and qualifications. Other education provided is generic occupational safety and health education related to the Western Australian mining industry. Workplace health and safety orientation education can take between one to five days, depending on the company and the work that the employee will do. To keep up to date with occupational safety and health there are workplace Tool Box Talks that are often presented by the mining industry safety and health representative, by other employees, or by safety professionals. At the start of a work shift in the mining industry there are Safety Shares in which employees share with the rest of their work team any safety related matters from the previous day, and lessons to be learnt (positive or negative) are discussed. This is followed by talking about the safety factors that are important for the work in the shift that the employees will commence. Finally there are Safety Stops, usually when employees need to be trained in important safety matters by their supervisor. All of this education has contributed to making the Western Australian mining industry one of the safest industries to work in.

## WORKPLACE SAFETY EDUCATION

The first accident prevention model was developed by Herbert William Heinrich who was born in America 1886 and died on the 22 of June in 1962 at the age of 76. Heinrich was an Assistant Superintendent at the Engineering and Inspection Division of the Travellers' Insurance Company when he published his first book called *Industrial Accident Prevention: a scientific approach*, in 1931. In the 1920s when Heinrich conducted the research on the insurance forms the employers blamed the workers' actions for causing accidents. This was similar to the blame the victim culture in Britain at this time. The five dominos in Heinrich's theory of accident causation were (1) Social environment and ancestry. (2) Fault of the person. (3) Unsafe conditions and / or unsafe act. (4) Accident. (5) Injury (36)(37). This model was important as it formalised the need to prevent accidents from occurring by removing step 3, which were the unsafe conditions and act that occurred in the workplace to cause the accident that resulted in injury (27). To assist with the prevention of unsafe acts this model highlighted the need for employee safety education.

An American company that developed formal workplace employee safety education in 1930s, following the publication of Heinrich's accident sequence model, was the Bell telephone company. This company trained its employees on safe work methods on the job and in the classroom. It displayed safety posters on the workplace walls to re-

mind workers to work safely and had printed work procedure instructions. There was learning from workplace incidents and the workplace incident and accident report produced each month was shared and discussed with employees so that they could learn about the causes of accidents and how to prevent them from occurring. This company did more than just have employee education as, to improve work related safety, it included putting safety in the design stage of workplace tools, testing equipment for safety and purchasing equipment that was safe to use (28). In the 1930s this was considered best practice in workplace safety.

In 2000 research was conducted to identify the aspects of organisational management that produce the best business outcomes in health care organisations. The findings of this research identified that what was most important was for the organisation to have a mission and a culture of care for everyone who came on to the business premises (29). This is the same as the conclusion that the Robens report came to and resulted in a general duty of care being included in workplace safety and health legislation. Part of the model developed from the health care industry research included management providing and facilitating employee education and training, and employees being educated and trained in work related tasks. This resulted in minimal employee occupational injuries and sick leave. For private hospitals there was an increase in the number of customers due to a high standard of care being provided and the research identified that this made private hospitals more profitable. For government hospitals there was a decrease in the number of customers due to employees knowing how to work safely and giving correct patient care. Having less customers in government hospitals meant that less of the general population's tax money had to be used to support government provided health care (29). When employees have work related education they are not only able to work more safely but are also able to work more efficiently and effectively. In contrast to this when employees do not have effective work related education and training major accidents can occur. An example of this is the Longford gas plant accident that occurred in Victoria, Australia.

At the Gas Plant at Longford in 1998 operators worked a 12 hour shift and during that time had to deal with 8,500 alarms so often worked in alarm mode. Through missing an alarm an operator allowed the plant to continue production with the condensate liquid above 100%. This caused the warm oil pumps to shut down. It took several hours for these pumps to be started during which time the metal heat exchanger became very cold (- 50 degrees C). When the warm oil was introduced there was brittle metal fracture and the gas explosion that killed 2 men, injured 8 other people and cut off Melbourne's gas supply for 2 weeks.

Part of the cause of the accident at Longford was that the Engineers, who knew about "brittle metal fracture", had been relocated from the Longford plant to the head office in Melbourne. The Royal Commission, which was held to investigate this accident, found that the control room operator was not to blame for this accident as neither he, nor anyone else at this workplace, understood what caused brittle metal fracture. When hundreds of litres of fluid began flowing on the ground the operators thought that the bolts just needed tightening. Maintenance men were called to re-tension the bolts, but they found that no adjustment was required.

ESSO insisted that they had trained the employees about aspects of operating the gas plant. When tested on-line about what they had learnt some of the employees had ticked the right answer without understanding what their answer meant. For example, an employee had ticked "thermal stress" as a correct answer because that is what the book said was the correct answer. When questioned in the Commission investigation, this employee said he had no idea what "thermal stress" meant. Not understanding what thermal stress was contributed to the employees' decision to re-introduce warm oil into cold pipes which was a cause of the pipes rupturing (39).



Following this accident the court ordered penalty that ESSO paid for failure to adequately train employees and to adequately train supervisors was \$(A) 2,000,000 (30).

As an outcome of this accident, and many other work related accidents, it became clear that employees must be education on hazard identification for the hazards or actions in their workplace that can cause harm, be trained in risk assessment, risk control and how to use the hierarchy of risk control measures. If an employee cannot implement risk control measures then they need to be trained to report the hazards that they identify to their immediate supervisor, or to the person who can provide the risk control measures required to make the workplace and work processes safe. As illustrated by the Bhopal case there is a need for the general public to also be provided with safety education.

### **PUBLIC SAFETY EDUCATION**

In Australia most of the safety education provided to the general public is related to road safety. This education is provided through the media, through fines and through car drivers loosing demerit points for driving over the speed limit or having unsafe actions when in a car. In Western Australia once the driver has 12 demerit points their licence to drive is lost for three months. There are no rewards for driving a vehicle well, except that the person can remain licenced to drive.

According to the Safe Work Australia (31) publication on Australian work-related traumatic injury fatalities from the year 2003 to 2015, two thirds (2,081 out of 3207) of work related traumatic fatalities involved vehicle collisions while the employee was performing work duties, most often on a public road, and 60% (803) of bystander (member of the public) work related fatalities were due to a vehicle collision while an employee was working, or the member of the public was hit by a work vehicle. In Australia the work related road transport fatality rate between 2003 and 2015 was eight times higher than the combined fatality rate of all other industry causes (31). In 2015, 115 of the 196 work related fatalities involved a vehicle. It was also noted that 187 (96%) of the work related fatalities in 2015 were male (31).

For children in Western Australia there have been a series of videos that have been shown on TV to promote children to think of safety before they act. WorkSafe Western Australia has 'Planet ThinkSafe' as an online educational resource for primary school children. It provides information to help children develop a positive attitude towards, and the skills to be, safe at school, home and in the community. It is part of the educational curriculum in primary schools and has cross-curricular courses and activities that have been organised into three levels; for lower, middle and for upper primary school children.

The WorkSafe SmartMove website is a comprehensive occupational safety and health educational resource for senior high school students and for new young workers that are entering the workforce on a work placement, work experience, or as a school-based trainee/apprentice. Features of the SmartMove website include having a SmartMove Certificate program containing one general and fifteen industry modules. High school students must pass and obtain this Certificate before being allowed to do industry work experience. The SmartMove Safety Passport program contains eight progressive online lessons that include videos, online learning activities, printable worksheets and a resource section that contains information sessions on current occupational safety and health topics. This program also has mapping documents and assessment tools for the national competency unit BSBWHS201A, over seventy printable occupational safety and health lesson plans and worksheets that provide over 100 hours of activities for educators.

In Western Australia it is considered that all children need to know the principles of safety and health before they enter the workplace,

have an understanding of how to identify work related hazards, assess the risk, report this risk to their supervisor and refuse to do any work that they do not consider safe for them to do.

### **IS EDUCATION & TRAINING ALONE ENOUGH?**

It is a start, but there are other factors to consider as is shown in the case of an employee at a Hay Baling business in Narrogin, who worked as a fork lift and press operator. This employee had been trained to drive a fork lift safely and had a High Risk Work Licence to operate a fork lift. Part of the training and competency assessment included not driving with the forks raised more than 30 centimetres. Following his training this employee had been warned on at least two occasions by his workplace supervisor not to drive with his forks raised.

On 22nd October the employee had loaded hay bales onto a feed table, reversed away from the table and set off in a forward direction with his forks raised at 1.7 meters high. This caused his view to be obstructed and he hit the driver, seated in another fork lift, with the fork prongs piercing the victim's torso and killing him. The employee was fined \$(A)11,000 and had to pay \$1,745 in court costs (32). In this case the employee had been trained to work safely, had been told by his workplace supervisor to work safely, but did not and, as a consequence, accidentally killed a fellow employee.

Another case where an employee had been trained to work safely happened in Queensland at the construction site for the ROMA liquefied Natural Gas project when Mr Glenn Newport died at work due to having a cardiac arrest brought on by dilutional hyponatraemia due to heat stress. How to work safely in the heat was discussed at the pre-start meeting and strategies to work safely in the heat discussed and implemented prior to Glenn commencing his work for the day. There were workplace policies and procedures that employees had been trained to use to work safely in a hot work environment (33). Despite all of the education and training Glenn, who was 38 years old, was still affected by the heat at his workplace and died.

Similarly, Adam Perttula, a Jumbo machine offsider, was working in a hot, humid underground gold mine in Western Australia when he collapsed due to heat stress and died. Resources Safety (34) Report No. 232 provided an industry alert on preventative action to be taken using the hierarchy of risk control measures to prevent further work related deaths due to the same or similar causes. The Resources Safety recommendations for working safely were as follows.

- (1) Elimination. So far as is practicable do not have employees working in the heat.
- (2) Isolation. Isolate heat sources through shielding, containment or using remote control machinery to perform the work where practical.
- (3) Engineering controls, such as providing adequate ventilation to achieve a healthy atmosphere and reduce the heat experienced by employees.
- (4) Administrative controls. Use safe work practices such as job rotation.
- (5) Education. Provide training to employees on risk assessment and risk control measures to be taken to avoid any harmful effects from heat.
- (6) Monitor effectiveness of risk control measures used.
- (7) Personal Protective equipment. This is last on the hierarchy of risk control measures and personal protective equipment to protect from the heat is used if the other measures used are not adequate (34).

In this hierarchy of risk control measures it is noted that education and training comes after hazard elimination, isolation, engineering controls and administrative controls. As well as using the hierarchy of risk control measures Resources Safety (34) provides information about the role of managers, supervisors and employees in preventing the heat related death of an employee.

The role of managers and supervisors include firstly to ensure all workers are trained to recognise the symptoms of heat stress (34). Then the supervisor should provide detailed safe work practices that identify the hazards and controls for working in hot and humid conditions and ensure that the risk control measures are implemented. 'If the wet bulb temperature exceeds 25°C, an air velocity of not less than 0.5 metres per second must be provided for underground workplaces or in a tunnel under a surge stockpile. Supervisors must also arrange urgent medical treatment for anyone suspected of suffering a heat-related illness' (34, p. 2).

All employees who have to work in a hot climate must understand the risks and symptoms of heat stress, and report any signs of heat stress to their supervisor. Employees also have the responsibility to ensure that they drink appropriate quantities of water to remain hydrated (34).

Using this case study it is clear that it is the workplace management and supervisor's responsibility to ensure that employees have the education and training to be able to work safely and that the employee has the duty to make sure that they understand how to work safely so that they do not harm their own health or the safety and health of others. However education, while very important, is not the only answer. Where hazards exist the hierarchy of risk control measures should also be used to make the workplace, work processes and actions of people as safe as is reasonably practicable.

## CONCLUSIONS

Benefits of having education and training to enable employees to have the knowledge to work safely include minimising the number of employee workplace accidents, injuries and work related ill-health and maximising employee productivity due to the fact that employees know how to perform their work correctly and safely (29). Other benefits are reduced legal costs, improved employee work related satisfaction, employee retention, reducing the cost associated with having to recruit and train new employees, reduced employee sick leave and lost work hours, reduced workers' compensation costs, the employer ensuring that they are meeting their legal obligations and responsibility for their employees (38).

The findings of this paper are that work related education and training are a pre-requisite for safety because, as was shown in the Longford Gas Plant disaster, in the Bhopal Union Carbide disaster, and in numerous other accidents, if employees do not have the education and are not trained in how to do their work safety major disasters can occur.

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