Atmospheric Monitoring for Confined Space Entry
By R. Craig Schroll, CSP, CUSA

Atmospheric hazards kill more people than any other hazard in confined space work. It is critical to the safety of entrants that atmospheric conditions within the confined space be effectively assessed prior to entry and monitored during the entry.

Atmospheric hazards that may exist within the confined space can be divided into three major categories.

• Oxygen deficiency or enrichment;
• Flammable gases or vapors;
• Toxic gases or vapors.

Any of these could pose a life-threatening situation within the space. Atmospheric hazards demand detailed evaluation and assessment prior to entering the space and must be continuously monitored during entry operations.

Oxygen Concentration

Atmospheric hazards may be present from several sources. It is essential to evaluate the situation in order to determine the likely sources of atmospheric contaminants. Both the space and area around the space and the work materials to be used during the entry must be considered.

Oxygen concentrations within the space should be between 19.5 and 23.5 percent to be considered acceptable. When oxygen concentration falls below 19.5 percent, it is considered oxygen-deficient. Oxygen-deficient atmospheres pose a direct threat to entry personnel who are not wearing appropriate respiratory protection.

Oxygen enrichment is a problem involving elevated concentrations of oxygen. When the oxygen concentration in the space exceeds 23.5 percent, it is referred to as an oxygen-enriched atmosphere. Health effects can occur at these elevated levels of oxygen. In addition to problems involved in breathing an enriched oxygen atmosphere, the potential for and magnitude of fires or explosions is greatly increased in these atmospheres.

Difficulties with the oxygen in the atmosphere of the space are one of the more common atmospheric problems. Thus, monitoring of oxy-

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gen content within the space should be the priority when conducting atmospheric testing.

**Toxic Gases & Vapors**
Fires or explosions in confined spaces are the second-leading cause of fatalities in these operations. Flammable gases or vapors present two primary hazards. These vapors can lead to fires or explosions either within or just outside the confined space. Exposure to flammable vapors and gases may also pose inhalation risks to entrants. For example, solvent vapors present in a high enough concentration can have a narcotic effect. The generally accepted level for flammable gases or vapors is 10 percent of the lower explosive limit (LEL) or less. (Note: Explosive limit and flammable limit terms are used interchangeably.)

Toxic gases or vapors may come to be within the confined space through three primary methods. Product or residue of product in the space; activities or materials taken into the space by the entry crew; and natural decay processes within the space. Toxic materials pose a difficult challenge in assessing the atmosphere within a space. To adequately monitor for toxic gases or vapors, these gases or vapors must be specifically identified. When the toxic gases/vapors are present due to the previous contents of the space or due to operations that will be conducted within the space by the entry crew, identifying the toxic material is relatively easy. However, toxic gases and vapors that could be generated by decomposition of materials within the space may be more difficult to identify. There is no generally accepted single value for accepted levels of exposure to toxic gases or vapors. The acceptable level of atmospheric contaminants must be assessed based on the knowledge of the specific chemical.

These allowable limits provide a margin that may be used. Remember, however, that the ideal atmosphere in the confined space would match the atmosphere outside the space: normal concentration of oxygen and no flammable or toxic gases or vapors.

Atmospheric monitoring should begin upon entry with a thorough hazard assessment of the space and the work to be performed in order to identify what hazardous atmospheric conditions may be present or occur during the entry. The configuration of the space must also be considered. This will affect whether remote sampling will be possible from outside the space. If all areas of the space cannot be assessed from outside the space, a plan for the initial entry to complete monitoring must be prepared, possibly including the use of respiratory protection. Once potential hazards have been identified, appropriate equipment may be selected for conducting the atmospheric monitoring.

**Monitoring Equipment**
Direct-reading atmospheric monitoring equipment may be divided into two broad categories: electronic and colorimetric. Electronic instruments may further be divided by display type, either digital or analog, and by the type of sensor used.

Electronic instruments are available with a wide variety of sensors. This discussion focuses on the more common types used in confined space entry operations. Oxygen sensors are a special type of electrochemical sensor. These sensors provide direct percentage readings. Flammable sensors are most commonly catalytic bead type. A less-common flammable sensor is the infrared variety. Both of these sensors provide percent of LEL readings. The advantage of the infrared sensor is that it is not oxygen-dependent. Toxic sensors in multigas instruments are typically electrochemical sensors. About one dozen toxic sensors are available. Two of the most commonly used in confined space work are carbon monoxide and hydrogen sulfide.

Instruments for confined space work typically have a four-sensor capability. Five-gas instruments are becoming more common as technology improves; if a third toxic sensor is needed, this makes it considerably easier. If additional toxic monitoring is the exception in the setting, a single gas instrument may also be used to supplement the multigas primary instrument.

In work environments where volatile organic compounds (VOCs) are likely to be present in confined spaces or introduced as work materials, then a photoionization detector (PID) is useful. These units provide ppm readings of materials such as solvent vapors that will be hazardous to personnel from an exposure perspective below the level at which they would pose a flammable hazard. The instrument uses an ultraviolet lamp to ionize the gas or vapor within the device. These instruments are very sensitive and quite accurate, even at low concentrations. The disadvantage is that they are not selective. Professional judgment will be critical in interpreting the readings as the instrument “sees” all VOCs with an ionization potential (IP) below the level of the lamp energy. 10.6eV is the most commonly used lamp. Lamps are available in several energies ranging from 9.2 up to 11.7.

To monitor VOCs with higher IPs, such as chlorinated solvents, then a flame ionization detector (FID) may be needed. A hydrogen flame is the ionization method in these instruments. This hydrogen flame operates at approximately 15.4eV so it will ionize materials that the PID would not.

A detailed discussion of colorimetric tubes is beyond the scope of this article. For substances that cannot be detected with electronic instruments, however, they are an important tool that may be required for evaluating the atmosphere within the confined space.

**Instrument Testing & Calibration**
Once you have selected the appropriate instruments, you need to confirm that
they are functioning properly. Each day the instrument will be used, it should be zeroed and bump tested. Zeroing must be performed in fresh air to ensure that the values reset to normal will, in fact, be accurate. Bump or function testing confirms that the sensors, display and alarms on the unit will operate when exposed to materials they are designed to detect. Bump test gas or calibration gas may be used for this test. This is not calibration, just a test of the basic operation of the instrument.

Calibration must also be done regularly. Calibration confirms or resets the accuracy of the instrument by matching the instrument reading to a known quantity. Field calibration is usually done as single-point calibration. Calibration gas usually uses a quantity that is near or slightly above the standard alarm set point of the instrument. At a minimum, the interval recommended by the manufacturer must be used. There is no significant disadvantage to more frequent calibration, so use a time frame you are comfortable with. Calibration equipment should always be readily available. Anytime you cannot explain the readings obtained or become uncomfortable with the readings, calibration is the first step in troubleshooting.

Calibration gas expires, so make certain that the gas is current. It is best to purchase calibration gas from the manufacturer of the instrument who has a vested interest in ensuring its accuracy. For the common confined space configuration of oxygen, flammable, carbon monoxide and hydrogen sulfide, a single cylinder that contains all of these gases is available. This simplifies the calibration process.

**Space Configuration**

The process of testing the confined space will be affected by the configuration of the space. Generally, the following provides an overview of typical methods for both vertical and horizontal entries.

For any entry operation, it is a good idea to take an area reading of the atmosphere before the space is opened. This will alert you to atmospheric conditions in the area that may pose a risk to the crew and also provide a baseline for ambient conditions in the area.

Atmospheric monitoring should begin with a thorough hazard assessment of the space and the work to be performed in order to identify what hazardous atmospheric conditions may be present or occur during the entry.

For both types of spaces, if any opening into the space exists other than the hatch that will be used for entry, initial readings should be taken through this opening before the hatch is removed. This will provide early warning if an extreme atmospheric condition exists in the space. If this is not possible, then conduct the first test immediately after the entry point opening has been opened slightly and before it is completely removed. For example, in a manhole entry where there are no vent holes in the manhole cover, the first reading should be taken after the cover is raised a little but before it is moved to the side.

For vertical entry spaces, the remote sampling tube needs to be lowered slowly through the entire depth of the space. This provides a cross-section view of the entire space. Conditions may vary within the space and it is critical that the entire depth be checked. Pay particular attention to low spots such as sump pits.

For horizontal entry spaces, it is important to extend your reach into the space without entering. Most manufacturers offer probes of various lengths as an accessory. These are often relatively short. Duct tapping the tubing to the end of a telescoping painter’s pole is often a good method for allowing extended reach into the space.

For atmospheric monitoring during the entry, two options are available. The end of the remote sampling tube may be placed near the work area and the instrument left with the attendant, or the instrument may be taken into the space by the entry crew.

Any time the space is left unattended for a period of time, the atmosphere should be checked as it was for the initial entry.

Effective atmospheric monitoring is critical to confined space safety. Careful attention must be paid to selecting an appropriate strategy, using the correct equipment, making certain that equipment is functioning correctly and interpreting the results. Modern instruments have made the mechanics of monitoring very easy. Do not be lulled into a false sense of security by this ease of use, however. SH&E professionals must still exercise judgment to ensure that the work environment is safe for the crew.

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Designing & Developing Web-Based Courses for Safety & Health Programs

By Dale O. Ritzel, Ph.D.

We are moving away from the one-dimensional model of teaching/training—where the instructor as the knowledge authority is located at one end of a classroom facility. The focus is now on learning instead of on teaching/training. Today’s learners are taking charge of their own process, becoming more involved in the choices of what, where and how they learn.

As a result, our roles as instructors will never be the same. The worlds of higher education and training are now vastly different from what most of us know and feel most comfortable with. As Yogi Berra once said, “I saw the future and it didn’t look the same.” I tend to say, “Someday is today.”

Web-Based Distance Learning
I refer to web-based distance learning as teaching and learning conducted via computer. This implies a connection to a computer system at a venue distinct from the learner’s personal computer, where this venue can be across the world or across campus or across the room. American Society for Training and Development (www.learningcircuits.org/glossary.html) defines web-based training as delivery of educational content via a web browser over the Internet, a private intranet or an extranet. Web-based training often provides links to other learning resources such as references, e-mail, bulletin boards and discussion groups. It also may include a facilitator who can provide course guidelines, manage discussion boards, deliver lectures and provide related activities.

Distance learning has generally been used to connotte teaching/learning that uses textual, video or CD materials exchanged by mail, or courses presented in an audio format, over the TV or via videoconference. In distance learning, instructors/trainers serve as guides and facilitators and concentrate on providing focus and feedback as they incorporate technical information into a usable structure. Instructors/trainers maintain a high degree of interactivity, helping students to find relevant information and transforming basic information into useful knowledge.

The 1998 amendment to the Higher Education Act includes a definition of distance education (distance learning) that carries the weight of law to encourage its use. The definition indicated in part that “the term distance education means a process that is characterized by the separation, in time or place, between instructor and student. Such a term may include courses offered principally through the use of 1) television, audio or computer transmission, such as open broadcast, closed circuit, cable, microwave or satellite transmission; 2) audio or computer conferencing; 3) videocassettes or discs; or 4) correspondence.”

The goal of web-based distance learning should be to manage the expectations of the distance learner. The goal should not replace the experience of, but meet the same goals and expectations found in a regular classroom setting.

Statement of Values
Any program or organization interested in distance learning—be it web-based or some other media—must develop a set of values for its distance-learning program. As an example, let’s discuss a set of values adapted from the University of South Florida’s School of Public Health distance-learning program. Some values are as follows, modified to reflect a safety and health program:

1) Prevention. The distance learning program will collaborate with others in building the capacity of the safety and health workforce to provide essential education and training. It will be structured and delivered in accordance with recognized principles of good practice in distance learning, as soon as it is approved and endorsed through appropriate channels. What this basic value refers to in the program offering education/training based on good learning techniques sound research.
2) **Community.** The distance learning program will both solicit and safeguard the unique and collective contributions of representative members of the safety and health community in pursuing its vision. It will also actively participate with other safety and health partners in pursuing their visions. Furthermore, the program will promote and help facilitate the establishment and maintenance of safety and health distance learning communities, whether geographical or virtual.

3) **Access.** The distance learning program will work with others toward maintaining and improving access to the program through developing and promoting an appropriate array of distance learning options and opportunities. Promoting access will include: marketing the program; faculty/trainer development, training and support; and ongoing quality management.

4) **Coverage.** Preventive measures require the adequate coverage of a population’s safety and health needs through the adequate provision of essential services, which, in turn, require an adequate quantity and mix of safety and health professionals to provide these services. The distance learning program will help access levels and types of educational needs and, on that basis, ensuring an adequate supply and an appropriate mix of safety and health professional education and training.

5) **Diversity.** The distance learning program is committed to taking every reasonable measure to ensure that the distance learners, as a group, are appropriately diverse and representative of the workforce.

6) **Equity.** The distance learning program will promote, endorse and practice policies and procedures that are fair and inclusive.

7) **Sustainability.** The continuance of the distance learning program requires the procurement and conservation of resources. This will be accomplished through the full partnership of entities with vested and emergent interests in ensuring the success of the program and related outcomes.

8) **Quality.** The distance learning program will ensure, maintain and improve its structures, processes and outcomes through periodic, ad hoc and ongoing assessment of the dimensions of accessibility, acceptability, efficiency, effectiveness and continuity.

**Strengths & Benefits**

Distance learning technologies offer a myriad of benefits to safety programs in higher education, including convenience, flexibility, effectiveness and efficiency.

**Convenience**

Distance learning technologies can provide convenient locations for both students and instructors. Many of the technologies, such as the Internet, videos and telephone, are easily accessed at home. Others, such as desktop videoconferencing, can be distributed from a single point, such as a university, to multiple remote sites (such as schools). Satellite transmissions can be viewed at specified sites or videotaped for later viewing at home or school.

**Flexibility**

Many forms of distance learning allow students to participate whenever they wish on an individualized basis. For example, some students may want to review a video in the middle of the night or read their e-mail during early morning hours. In addition, one student may wish to spend 30 minutes reviewing a website, while another spends an hour.

**Effectiveness**

Not only is distance learning convenient, it is also effective. Several research studies have found that distance learning is equally or more effective than traditional instruction when the method and technologies used are appropriate to the instructional tasks; when there is student-to-student interaction; and when there is timely teacher-to-student feedback (Moore and Thompson 1990; Verduin and Clark 1991). In a study conducted at California State University, students who participated in a web-based course achieved significantly higher test scores (Schutte 1996).

**Interactivity**

Contrary to popular opinion, distance learning courses can offer increased interaction with students. In particular, introverted students who are too shy to ask questions in class will often open up when able to interact via e-mail or other

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individualized means. Through increased interactions, teachers can better meet individual student’s needs.

Computers are designed for human interface. The interface translates into possibilities for more active learning. A Chinese proverb applies: “I hear and I forget. I see and I remember. I do and I learn.” Interaction can be created through web links, web hunts, clicking buttons, bulletin boards, web chats and group work.

**Equity**

Educational inequity is a major issue in this and other countries. Rural and poor urban schools often have less contact with educational trends, fewer qualified teachers and more need for technology. Distance learning offers great potential for alleviating these issues and has been employed effectively in Canada and Australia—two countries with geographically diverse student populations.

**Interactive Web-Based Distance Learning**

The web is a major delivery tool for computer-based training, both in real-time and in recorded versions. Realtime web conferencing allows students to participate in lectures and interact with the instructor and fellow students. Students from locations across the country and internationally can see the visual materials, hear the instructor, and communicate by using a microphone or typing questions into the system’s chat box or chat room. Web-based classes may be stored so that students can retrieve the class at a later time. Chat room, e-mail and bulletin boards are available for students to communicate with the instructor and each other and to stimulate interaction and networking.

In some classes, instructor notes and student questions are available on the web as well. The instructor may meet virtually with students during office hours and students may work together to solve problems and conduct research. Students also have access to online libraries, as well as syllabi, files and assignments. This opens the way for the incorporation of web-based information into classes and encourages the use of websites to organize course materials.

**Teaching/Training Methods & Materials Development**

Based on my experience, web-based course development will not make life easier with regard to teaching safety and health courses. The three online courses I have developed have taken at least 200 hours for course planning, development and evaluation. From my days of both programming and teaching computer programming, it is also true that in developing web-based courses, you need to spend about 40 percent of your time planning (what you do on paper, organization, putting together the appropriate content); 40 percent of your time putting material in a web-based format (via HTML programming, using WebCT, Blackboard, etc.); and 20 percent of your time in correcting errors related to links, content, etc.

One basic lesson learned from delivering web-based distance learning programs (and for that matter, all distance learning) is that the instructional design of a course must correspond to the delivery technology. Appropriate preparation of course materials and the inclusion of interactive exercises and instructor training are also essential. Most instructors/trainers have immense subject matter knowledge, but minimal training in instructional methods. Instructors/trainers need help to use web-based learning technology as a teaching tool and need help to prepare materials that take advantage of the system features.

It is also important to make the web-course design humanizing. This refers to including warmth, creating trust and adding identification. Warmth relates to having informal persona and tone, using humor, using the student’s name during interactions, creating online study groups, etc. To create trust, you need to be consistent in page layout, placement and content. Avoid too many gimmicks and pop-ups. Create simple URLs. Also, answer all student/participant e-mails in a timely manner.

By adding identification, you need to create an instructor page about yourself. Consider having a web page that highlights the students in the course with pictures and bios. Create a theme for the web-based course. Utilize backgrounds, gifs, music and film that link with the theme. Creating a virtual classroom homepage is another option.

Design the course with a specific audience in mind. Do not make it too generic. Your language, tone, modeling and directions will need to change as the audience changes. Courses for undergraduates should be different in design and approach than courses for graduate students.

If giving specific assignments, give students/participants a time limit for responding. Have students/participants respond to bulletin board postings. Be sure to make the response dependent on the posting.

**Goof-Proof Tips**

• Make sure students/participants can receive and send e-mail messages. Take time to show students how to use the e-mail system and how to send attachments. Consider a “boot camp” before class begins (an online instructional session on using e-mail, attachments, links, the web, etc.). Make sure students/participants receive e-mail receipts for work sent to you. Give them plenty of time in the beginning to accomplish Internet tasks. To make sure students understand and can do what is expected, complete the task along with them. Consider the downloading time of your pages (some computers are unable to download large HTML files).

• Consider keeping distance-learning-only office hours. Let students know that you will be available online for any questions during a specific time period, then be there to respond to questions and concerns. Remember, you will spend about one hour per week per student in a web-based course. For example, if you have one section of a web-based course with 20 students, you will spend on average of 20 hours per week if students are completing assignments by due dates.

• The first day of class is the most important for web-based courses. A good first impression goes a long way. If the first day goes well, you are off to a good start. If it goes poorly, you have to perform damage control. You cannot control technical difficulties, but you can control how the content is delivered. The following suggestions will help the first day go smoothly:
  1) Indicate course goals and objectives. Describe what will happen in the course.
2) Solve problems. Direct students to appropriate technical help in case they need it. Students may need help to register for the course, set up e-mail accounts or obtain course materials. Deal with student problems right away.

3) Invite interaction immediately. Encourage students to participate in the course and contribute as soon as possible.

4) Always give students your best. Do not wait until the second or third week to have them start in the course. Jump into the content right away. Make the first unit the most interesting and strongest of all. Get their interest early and keep it.

**Student Success in a Web-Based Course**

While developing and teaching web-based courses over the last three years, I have learned that students take different approaches to completing (or not completing) web-based courses. I believe that the key to completing the course during the semester in which the student enrolled is to treat it like a regular lecture class where you meet two to three times each week.

I share the following information with my students:

“As you attend classes some three or more times a week and work on assignments for another three+ hours a week, take this web-based course the same way. Get into a regular schedule of attending ‘class’; that is, schedule about five to six hours each week (during a regular semester, 10 to 12 hours during the summer) for working, reading and completing assignments. Make it the same time each week and stick with this schedule. It is too easy to procrastinate. You will have two to three assignments each week on average (in a regular semester).

“All students must complete the course within the semester that they enroll. If you start early in the semester and do some work each week, you will get it done. Do not be surprised if I get on you if you are not working on the course and sending e-mail assignments. I have had students complete the entire course in four to five weeks. You can do the same.

“Some assignments are only listed in the course syllabus. Some are easily viewed in the list of topics or subtopics on the course web page(s). Some assignments are within the topic areas, and you will have to go through the content and topic areas to find these assignments. A list of all assignments is contained in the course syllabus. The list of assignments may not be shown in the order that they would appear in the topic areas. I will try to answer any questions you have about course assignments. Send those questions to me at safety@siu.edu.

“If you want to start the course early, please do so, but please contact me. The course is set up so that assignments have to be completed in a separate format, then the test answers, paper, etc., are sent to me electronically. I am trying to make this course a paperless course and handing papers in to me or sending them to me via snail mail defeats this purpose. When sending assignments, you can do so either one or both of two ways:

1) Send the assignment within or as a part of the e-mail message itself. Some students find that this is a good way because it eliminates having to type the answers or paper in a word processing format, then sending the paper as an attachment.

2) Send the assignment as an attachment to an e-mail message. This provides the cleanest copy. However, you need to know how your e-mail program allows you to attach a file to a message. Usually there is an “attach file” item under the “message” menu. After highlighting the “attach file,” locate the drive where you saved the file, then attach it to the e-mail and send the message.

“Some students will highlight the assignment (for example a test) on the web and copy it to a word processing file, answer the questions in the file format, save the file, and send it as an attachment. Any method is okay with me.

“I will try to give you a grade on any sent assignment within two days. There are times when I am out of town and unavailable for some days. I will usually send the students enrolled in this course an e-mail indicating my unavailability from the university.

“All assignments sent to me should include in the subject area of the message the name of the assignment and your name. I get many assignments from students with just their e-mail address and nothing else. If you send an attachment as a part of an e-mail message, make sure your name is also on the attachment file (name at top of a paper). Since some students will send me assignments from two to four different e-mail addresses, putting your name on the attachment helps me keep track of who sends what and when, in order.

“If any web-based link is unavailable to you (it will not show or load) when you try to access it, please send such information to your instructor. From time to time, web page URLs change. You can help me by sending information on such. However, most of the time, when a web page does not load on a student’s computer, the computer does not have enough RAM. This course works best when you have a computer with Windows 95 or newer and at least 32mb RAM or greater (64mb is better). If your computer is five to six years or older, it may not have enough RAM.

“Please keep track of what assignments you send and the score you receive on each. I keep a copy of everything you send and keep a record of the grade earned on each, but you can help by keeping track of your own scores. Print a copy of the course syllabus (assignment) from the web and fill in the grade for each assignment when you receive it. When you are nearly complete with the course, send me an e-mail and I can provide for you what you have left to do in the course.

“It’s also best if you keep a copy of all e-mail messages I send to you and you send to me and keep file copies of your papers until you receive the final grade for the course from the university. Sometimes, I may not record a score for an assignment (usually because of receiving many assignments at the same time) and you can help me and yourself by keeping this information, too.

“From time to time, I may ask you to redo an assignment because I feel you can do better or need to provide more complete information. Please redo the assignment when asked. A better score on the assignment is to your benefit.

“At the midpoint of the course, you are asked to request videos from me. I need your name and address (unless you are
local, in which case I request that you pick up the videos from the Safety Center) to send you the videos.

“I typically receive 600 to 800 assignments in this course from students enrolled each semester. As indicated, it is best to send me the assignments as you do them, instead of sending me many, most or all at one time.”

In my experience, students who follow these guidelines are more successful in the course.

**Program Evaluation**

Evaluation is an essential component for continuous program improvement. Current evaluations of web-based distance learning show that students who have attended the same class on-campus and those who complete it via distance learning have had identical outcome performance measures. In addition, student satisfaction is comparable. Ongoing or formative evaluation provides feedback for continuous presentation and material improvement, and ensures that student learning meets specified learning objectives. Remember, if students are not successful in the web-based course, then you are not successful.

**Conclusion**

Web-based distance learning course and program development is a lot of work. The effort is worth it when you see people learning in a new format. Program development can be a lot of fun, too. Once a course has worked into a web-based format, you will be changing and updating it each semester. Sometimes, factors beyond your control will cause you to make changes that were not anticipated. In my case, when the Sobig.F virus hit the Internet and e-mail last August, my web-based courses were almost shut down. I had to remove most of the graphics and pictures from the web pages so students could start the courses. As a result, I’m in the process of putting the courses into different web formats so this problem will be minimized in the future.

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Fighting the Contractual Liability Virus

By Larry Hoellwarth, Esq.

During the past few summers, a major new disease spread by mosquito bites has spread across the U.S., and is often not detected until too late. West Nile Virus may infect anyone, but is most deadly to those who are elderly or weaker, and seems to have little impact on those who are strong and healthy.

Similarly, a virus is infecting the construction industry—in the form of craftily worded clauses inserted into the fine print of consulting contracts, then imposed by strong owners and general contractors on smaller, weaker subcontractors, such as SH&E professionals. Just like the West Nile Virus, an SH&E consultant who signs a contract without being vigilant about the fine print may find that s/he has contracted the contractual liability virus only after it is too late, after an accident has occurred at the jobsite.

SH&E professionals dedicate themselves to vigilance regarding the safety of workers. However, SH&E professionals must also protect themselves from exposure to injury by unfair contracts. This article highlights some danger points and encourages vigilance in everyday contract negotiations.

A Current Example: A Pending Suit
In March 1999, an SH&E consultant in Chicago was approached by a major highway contractor and the Illinois Dept. of Transportation regarding performance of site inspections audits and safety training for a multi-million dollar, two-mile long bridge reconstruction on the Stevenson Expressway spanning the Chicago River. The SH&E professional was told to sign an “Open Purchase Order” for a sum “not to exceed $30,000.” Unfortunately, the backside of that simple form contained 15 paragraphs of fine print, labeled “Supplementary Terms and Conditions.”

Buried at paragraph 9 was a clause entitled “Indemnity” that stated in part: Seller [the safety professional] hereby agrees to indemnify Buyer [the multi-million dollar general contractor] for any loss, expense, recovery or settlement, including counsel fees and costs of defense which arise from any demand, claim, suit which may be asserted or brought against Seller or Buyer... whether or not such injury is due to or chargeable to any alleged negligence of Buyer, the owner... or the alleged negligence of any employee of Buyer, Owner...

When the general contractor (the “buyer”) was sued for injuries incurred by workers who fell from a man-lift, it sued the SH&E professional for millions of dollars in indemnity, greatly exceeding the insurance coverage available for that consultant. But for that contract, the SH&E professional, who was paid a relative pittance and was on the site only a few hours a week, would have been able to argue that he was responsible only for his individual share of the liability (comparative fault) in causing the injury.

Under Illinois law, the jury verdict form would have required the jury to “Apportion damages by determining the relative degree of fault, if any, of each (person) named or described on the verdict form.” Thus, the SH&E professional would have been liable only for the percentage the jury allocated to him. However, as a result of the fine print on the backside of the purchase order, that SH&E professional is at risk of being held liable for the entire liability of the general contractor, with the workers’ employer being excused from liability under the Workers’ Compensation Act.

The exposure now being potentially foisted upon SH&E professionals is unjust and unwarranted, and is in derogation of the general rules and principles of Illinois tort law. That contractual provision, if enforced against that safety professional, could result in huge liabilities that are not only unfair and unwarranted, but also uninsured (the subject of an article in the next issue).

If the SH&E professional is able to avoid this liability, s/he will be able to do so only by the expenditure of significant legal expense to convince the court not to impose such unjust imposition of liability.

The Silver Lining
Luckily SH&E professionals have some help. The Illinois legislature has passed the Construction Contract Indemnification for Negligence Act which provides that “every covenant, promise or agreement to indemnify or hold harmless another person from that person’s own negligence is void as against public policy and wholly unenforceable” (740 ILCS 35/1).

Also fortunate for this SH&E professional, Illinois courts, as the courts of many other states, have held that these types of indemnity clauses are to be “strictly construed” (i.e., enforced only to the extent such clauses are perfectly clear and expressly and unambiguously agreed to). Courts generally hold that ambiguous indemnity contracts are to be construed against indemnitees, particularly because the indemnitees are the drafters of such contracts.

Lessons to be Learned
This professional may win this battle, given the support by the Illinois legislature and Illinois courts in previous decisions. However, SH&E professionals in other states may or may not benefit from these same types of defenses against such oppressive contract wording. New York and other major industrial states such as Michigan, Ohio and Pennsylvania have similar protective statutes. For example, the New York General Obligations Law Section 5-322.1 states in relevant part: A covenant, promise, agreement or understanding in, or in connection with or collateral to a contract or agreement relative to the construction, alteration, repair or maintenance of a building...purporting to indem-

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ify or hold harmless the promisee against liability. . . caused by or resulting from the negligence of the promisee, his agents or employees or indemnitee, whether such negligence be in whole or in part, is against public policy and is void and unenforceable. . .

However, many states do not have such a protective statute. Thus, if you are engaged in multistate consulting, you should require that the contract have a choice of law clause choosing favorable law, such as that of Illinois or New York. Moreover, these protective statutes are usually limited only to the construction arena. Thus, SH&E professionals engaged in performing safety consultation regarding industrial machinery or industrial activities may not enjoy these same protections. Whether they do or not is dependent on each individual state’s law.

In California, this type of contractual wording may be objected to as “unconscionable.” California Civil Code §1670.5 provides that if a court finds as a matter of law that a contract was “unconscionable at the time it was made,” then the court “may refuse to enforce the contract, or . . . it may so limit the application of any unconscionable clause as to avoid any unconscionable result.” Under California law, a contract is considered unconscionable where it is “so one-sided as to shock the conscience”; that it imposes unduly harsh or oppressive terms; or that it results from “oppression and unfair surprise.” Oppression is deemed to be present when an agreement includes terms that have been imposed as a “contract of adhesion,” (i.e., where there was no real negotiation, the terms being imposed by the stronger party on the weaker party).

**What You Can Do**
What does all this mean in the real world? It means SH&E professionals need to be vigilant and assertive in fighting for a fair contract at the beginning. It also means that if an unfair agreement has been imposed on you by undue or oppressive means you may later be able to block the enforcement of the agreement, in effect turning the unfairness and unfairness of the contract against the party who unfairly imposed it on you. In combining these two concepts, it means that you should argue to clients that if they seek to impose such agreements, the agreements may not be enforceable any-

way. In many cases, owners and general contractors will be more reasonable and accommodating than were their lawyers who drafted the contractual agreements. You certainly must give yourself a chance by putting up a fight. A reasonable contractor will recognize that if the terms are too oppressive, and if the case were to go to a jury, the jury will be reluctant to enforce any such oppressive clauses. Thus, you may have more bargaining leverage than you expect, if you present these arguments correctly.

Another uncertainty omnipresent in such negotiations is whether there will be insurance for such “contractual” obligations. Under most policy terms, there can be no insurance coverage for such contractual obligations, especially where they are entered into in derogation of general state law and the “common law,” (i.e., the decisions of courts over the years). Explain the potential lack of insurance coverage for such claims to convince your client it is wrong to impose such terms.

The more extreme and “overreaching” of contractual wordings are at risk of being rejected and not enforced by a court. Thus, if a very bad contract is being forced on you, ask your attorney whether it is enforceable.

**The Best Result: Reverse Indemnity**
The bottom line is that SH&E professionals who are typically on job sites only for brief periods of time, and have no control or direction or constant level of supervision over the activities at a jobsite, as a matter of fairness should argue that reverse indemnity is warranted: SH&E professionals should be indemnified and defended by the general contractor, owner or employer or whomever has employed the SH&E professionals. Many practitioners are able to negotiate contracts that contain wording such as the following:

**Indemnification**
Company understands and agrees that Safety Consultant is acting as a consultant only and does not have the right, authority or responsibility to enforce any Company policy or to control or stop the work. Safety Consultant cannot verify compliance with every OSHA 1910 regulation, nor can it identify every workplace hazard.

The Company recognizes that the responsibility for controlling and directing workplace safety is a non-delegable duty of Company. Company therefore agrees to hold Safety Consultant harmless and to defend and indemnify Safety Consultant and its officers, directors, employees and agents from any and all losses, claims, damages and liabilities under any statute or common law or otherwise, unless Safety Consultant has engaged in willful or intentional misconduct or has affirmatively taken control over the work or operations of the Company.

**A Realistic Goal**
The practical objective is simply to eliminate all indemnification clauses, and allow the reasonable and fair allocation of fault by our tort system and by juries. In most cases, the SH&E professional will benefit tremendously because a jury, exercising its common sense, will recognize that the SH&E professional’s role is normally limited and constrained. While there are stories about runaway juries, most jurors are working people who believe in fairness and reasonableness. They will give you much better treatment than the lawyers writing those ugly contracts for the “big boys.”

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**North American Occupational Safety and Health (NAOSH) Week**
**May 1 - 7, 2005**

The goal of the annual North American Occupational Safety & Health (NAOSH) Week is to focus the attention of employers, employees, the general public and all partners in occupational safety, health and the environment on the importance of preventing injury and illness in the workplace.
OSHA & Conveyor Safety

By George A. Schultz, P.E.

In the 1970s, the OSH Act was being adopted and 29 CFR 1910.186 was assigned to cover conveyor safety. At the same time, OSHA prepared an initial draft calling for various safety measures (Table 1). At that time, OSHA also reviewed ANSI B20.1, Safety Standards for Conveyors and Related Equipment (as issued in 1972.) This standard was prepared and approved by the American Society of Mechanical Engineers (ASME), and recognized and utilized by conveyor/system engineers and manufacturers. OSHA rejected ANSI 1972 B20.1 as being “too specific.” The 1972 standard was rewritten by ASME and reissued as ANSI B20.1-1976—a performance standard. This was also rejected by OSHA and while work and discussions continued on 29 CFR Part 1910.186, all activities were stopped in 1981.

Present Status
Conveyors are used in many industries to move materials in all directions. While conveyors reduce manual handling, they also present hazards associated with their mechanical motions. Often, conveyor-related injuries involve a worker’s fingers, hands or arms being caught in a nip or shear point that can occur in the following situations:
- cleaning and maintaining a conveyor, especially when it is still operating;
- reaching into an in-going nip point to remove debris or to free jammed material;
- a cleaning cloth or an employee’s clothing gets caught in the conveyor and pulls the worker’s fingers or hands into the conveyor nip points;
- improperly guarded nip and shear points.

ANSI B20.1, first issued in 1947 and reissued to the present, is generally recognized as the most complete and authoritative source on conveyor safety available. However, OSHA has limited its reference to this standard in its standards to the following:
- 29 CFR 1910.218: Forging Machines (J); three references to ANSI B20.1-1957.
- OSHA correspondence and reports on occasion will reference ANSI B20.1. With regard to these references:
a) is not applicable to general industry;
b) is limited to a single industry and is out of date; and

c) is generally provided after an accident has occurred. OSHA standards that can be applied in part to conveyor safety include:
- 1910.147: Control of Hazardous Energy (lockout/tagout).
- 1910.145: Specifications for Accident Prevention Signs and Tags.

<table>
<thead>
<tr>
<th>TABLE 1 Conveyor Safety Measures</th>
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<tr>
<td>1) All conveyors must be tested, including switches and guards, before being placed into initial service.</td>
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<td>2) A visual check must be made before a conveyor system is started, and if this is not possible, audible or visible signals must be installed.</td>
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<td>3) Only trained operators are to be permitted to operate a conveyor. Methods are to be devised to train operators for safe conveyor operation.</td>
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<td>4) A conveyor shall only be used to carry its design load at a set speed.</td>
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<td>5) No employee shall climb on any conveyor component.</td>
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<td>6) No employee shall ride on a conveyor.</td>
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<tr>
<td>7) Casings, conveyor guards and safety devices shall not be removed or bypassed during operation.</td>
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<tr>
<td>8) If an operator’s station is not manned or is not within voice or visual contact with other locations, it is to be equipped with emergency stop buttons, pull cords, limit switches and other safety devices.</td>
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<tr>
<td>9) Lubrication fittings shall be placed in accessible and guarded locations. Drop pans are required where necessary.</td>
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<td>10) Open-top containers carrying hazardous materials must be covered.</td>
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<td>11) Guarding and centering devices are to be provided to prevent loads from falling.</td>
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<td>12) If a load on a conveyor is hazardous, a load detector device must be installed.</td>
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<tr>
<td>13) If a conveyor passes through a floor opening, it must be guarded and warning signs provided.</td>
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<td>14) Conveyors passing through fire-resistant floors or walls require suitable protection.</td>
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<td>15) Daily visual inspections are required of all conveyor components that could create a hazard to employees.</td>
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<tr>
<td>16) Repair and servicing of conveyor systems by trained personnel is required, including lockout and repair area protection and warnings.</td>
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NOTE: These OSHA draft conveyor safety regulations also covered a few specified types of conveyors in rather brief terms.
Proposed Changes
Currently, OSHA has published general industry standards that specify safety, operating and maintenance requirements covering overhead and gantry cranes (1910.179) and powered industrial trucks (1910.178). Both of these standards reference operator “training” requirements, per 1910.179 (a)(35) and 1910.178 (1)(A), et al.

The crane and forklift truck information provided by OSHA has resulted in the clarification and improvement of the owner’s/operator’s ability to comply with the agency’s safety standards. It has also led to a multitude of books and training sessions.

In contrast, the conveyor safety standards information provided by OSHA is fragmented and limited as to its content. It does not clearly identify the owner’s/operator’s responsibilities for conveyor safety and training. To my knowledge, at present only one book, two videos and no formal training sessions covering conveyor safety are available to industry. ANSI B20.1 states:

The design and installation of conveyors and conveyor systems should be supervised by competent engineers. Likewise, the operation and maintenance of conveyors should be supervised by trained personnel. It should be recognized that in the application of this standard, there may be responsibilities divided among the owner, the management or engineering consultant, the manufacturer, the installer, the operator and the user of the conveyor or conveyor system. It is most important that operating personnel or anyone who has occasion to be near equipment be thoroughly instructed in safety precaution.

To meet the ANSI B20.1 requirement and clarify the owner’s/operator’s responsibilities for conveyor safety, OSHA needs to issue 1910.186, Conveyor Safety, as a performance standard that covers the following topics and cross references ANSI B20.1:
1) equipment safety;
2) personnel safety;
3) operations and maintenance;
4) employee training.

While this step may not eliminate the current yearly average of 9,000 to 10,000 accidents, 30 to 40 deaths and high insurance costs, it would provide centralized conveyor safety control, which presently is lacking and is a fundamental requisite for controlling injuries. It could also reduce typical hazards involving conveyors by requiring owners/operators to comply with the following conveyor safety practices:
- Provide guards for all sprockets, chains, rollers, belts and other moving parts.
- Use prominent warning signs or lights to alert workers to conveyor operation.
- Ensure that start buttons have guards to prevent accidental operation.
- Ensure that conveyor controls or power sources can accept a lockout device to allow safe maintenance practices.
- Equip conveyors with emergency stop controls that require manual resetting before resuming operation.
- Make sure clearly marked, unobstructed e-stops are within easy reach of the workers.
- Provide employees with initial training and periodical retraining in conveyor safety applicable to their conveyor system.

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Metalworking Fluids:
Occupational Exposures, Including Biological Contaminants: Part I

By Gary M. Hutter, Ph.D., P.E.

Editor’s Note: The U.S. Third Circuit Court of Appeals recently ruled in OSHA’s favor in an action brought by several unions to try to force the agency to promulgate a standard to protect workers from machine fluids. The court found that OSHA’s decision to remove the metalworking fluids item from the regulatory agenda was neither arbitrary nor capricious.

Metalworking fluids are important in the operation of certain metalworking machinery and the processing of certain parts. These fluids can cool, lubricate, clean, improve tool performance and inhibit corrosion of production parts. They may be applied in areas where there is great physical pressure, high equipment operating speeds and elevated temperatures. The range of fluid application may be by a fine spray or by flooding the work areas. Recycled metalworking material may have chemical additions to refortify it and to reduce biological contamination. These multifaceted applications and demands have caused metalworking fluids to evolve into a diverse collection of fluids with many characteristics and formulations.

These fluids can become biologically fouled or cross-contaminated with other tramp oils. Human exposure can occur from direct skin contact or from the inhalation of mists and vapors. Over the past two decades, the potential hazards associated with certain exposures to these materials have been recognized. Both acute and chronic adverse health effects are associated with these exposures, and great efforts have been implemented to define cause-and-effect relationships and to establish new exposure standards.

This article is written for an audience not trained in epidemiology or industrial hygiene, and, therefore, reviews some concepts of epidemiology and industrial hygiene in the context of metalworking exposures. It addresses some of the
The Complexity of Metalworking Fluids & Establishing a Cause-and-Effect Relationship

Metalworking Fluids & Applications

In this context, metalworking fluids are those liquids used to lubricate, prevent rust, and cool tooling and dies for the purpose of improving metalworking operations (40 CFR CH 1 747.195 (B)(2), 7-1-85). This is intentionally a very general definition; as the application of metalworking fluids has increased to include many different operations, the fluids have evolved to include many new classifications and types, and the means of application of these fluids has improved to minimize use and increase efficiency.

Estimates suggest that more than 100 million gallons of such fluids are used annually within the U.S. (Nachtman 1). The use varies considerably from facility to facility based on application method, machining operation and production levels. Facility ventilation is likely to be specific to operational demands. This means there is no “standard” work environment, but rather that each installation will have different air contaminant generation and removal rates.

Application of metalworking fluids is often at or near the point of metal-forming operation; in larger installations, metalworking fluids may be recycled within the machining operation for filtering and reapplication; in many situations, metalworking fluids will be fortified with various components to maintain their stability and performance characteristics. This means there is considerable variability in the mechanics of forming airborne contaminants and the resulting exposures.

While metalworking fluids can be subdivided into groups, Glass has three major subcategories: neat or mineral oils, emulsified oils and water soluble synthetic fluids (5). Mineral oils are refined petroleum-based lubricants, emulsified oils are suspensions of petroleum-based oils into a water solution; and synthetic lubricants are non-naturally occurring fluids most often based on petroleum or polybutene feed stocks. An additional category could include pastes or semisolid materials (Nachtman 87-89). This variation means that two very similar plants could have significantly different proportions of air contaminants depending solely on the selection of metalworking fluids.

The composition and machine-type application of metalworking fluids is quite diverse and evolving. Rudnick (1999) lists at least 17 categories of synthetic fluids, and the American Society of Tool and Manufacturing Engineers (1967) lists more than 29 machining processes employed over the past 30 years regularly using metalworking fluids. Cookson (1971) reported that there were more than a million machine tools in operation in the late 1960s; this number may have doubled by the end of the century. Annual sales in the U.S. of new metalworking equipment topped $2.7 billion (Celeste 1984).

These kinds of variations have resulted in significant differences in the magnitude, composition and physical characteristics of workers’ exposures, and chronic dose levels; however, there has been an appreciation over the years of an increase in the number of adverse health effects from working in this industry and around these processes. The following section addresses some epidemiological methods used to evaluate the cause-and-effect relationships of exposure to metalworking fluids.

Epidemiological Methods Used to Identify & Establish a Cause-and-Effect Relationship

Epidemiology is the study of the distribution and determinants of disease and injuries in human populations (Mausner 1985). It is the major method used to establish a cause-and-effect relationship between occupational exposures and adverse health effects.

At least six basic components are used to help establish the presence of a cause-and-effect relationship:

1) a dose-response relationship;
2) a consistency of adverse health effects associated with exposures;
3) a specificity of the association of disease with the exposure;
4) a correct temporal (time) relationship between the exposure and the health effect;
5) a biological plausibility for the adverse health effect and the exposure;
6) a significant strength of the association between exposure and effect.

In effect, there should be more adverse outcomes for higher or longer exposures; the adverse health effects should be consistent across borders and industries with similar exposures; the adverse health effects can be measured and are just not ephemeral subjective events; the latency period between exposure and the adverse effect make sense (e.g., tumors and other tissue changes take time to grow and manifest themselves); there should be some plausible explanation of the mechanism of exposure and how the chemicals could cause the adverse health effect; and the size of the study population and health events should be sufficient to be able to detect and quantify the cause-and-effect relationship. It would be rare that all six components are included and evaluated in any single study. More commonly, a series of studies evaluate these various aspects to build a basis for the cause-and-effect relationship. Through the course of several studies, conflicts in findings and new directions for studies often occur, but generally a consistency in associations will surface.

This series, or iterative process, is also useful as a means to diminish the effects of bias within any one study. “Bias” in epidemiological studies is any systematic means that tends to produce results different than the true value (Last 1983). The use of the term “bias” in this context does not carry the imputation of prejudice or the experimenter’s desire for particular results; rather, it suggests that there was some consistent measurement error which tends to distort the normal distribution of cause-and-effect relationships. An example could be that workers who have a disease may have thought more about their workplace exposures and, therefore, have a better recall concerning the chemicals they worked with than other workers who are not sick.

This effect would be called “recall

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bias,” but there are many other forms of potential bias in an epidemiological study. Examples include: length bias, resulting from a study time period and a disease onset latency period that are incompatible; or selection bias, resulting from some disproportionate characteristic between sampled groups that results in too many or too few subjects in a particular study group; or withdrawal bias, resulting from a disproportionate number of healthy subjects dropping out of a study compared to ill workers. The potential for many of these biases is exasperated by the fact that most of the epidemiological studies are retrospective, or are looking back in time at some past or earlier exposure event(s).

“Retrospective” epidemiological studies, or case-control studies as they are often classified, are often used to evaluate the health-effect outcome from past exposure conditions. For metalworking fluid exposures, this type of study tries to identify two almost identical groups of workers, with the exception that one group has a particular disease and the other group does not have the disease. Once stratified into these two groups, the quest is to determine what unique differences in exposures could cause this disease pattern.

Due to this retrospective, or looking backward in time perspective, it may be easier to understand the potential for some of the above referenced biases, and how diseases with long latencies may go undetected from studies of groups from the recent past; or how participant recall about a particular set of exposures may be poor for study groups exposed long ago. In addition, the number of participants may be low due to relocations, retirement and deaths, and smaller numbers of participants mean the statistical power of a study may be weak.

Several statistical parameters are used for the numerical measure of the strength of an epidemiological study. These parameters may compare mortality rates of the exposed group to the nonexposed group and show that they are most likely different; show an increasing trend of disease with increased exposure; or they may show vulnerability to disease within certain exposed groups. Standard mortality rates compare the death rate of a study group to a standardized comparison group.

Numerical values greater than one means an increased adverse effect. For example, a standard mortality rate of two means a member of the study group is twice as likely to die than a member of the reference group. The “odds ratio” and “relative risk” are two other common measures that compare the odds or risk of an individual in the exposed group becoming diseased when compared to a person in the nonexposed group. Again, a numerical value greater than one generally means there is an increase in adverse effects. Almost all modern epidemiological studies have some numerical measure or statistical qualifier of the effect under study and these are only three examples.

When one of these measures is used, or if some other parameter is used, most studies include confidence intervals for the measurement parameter. The methods of determining confidence intervals is beyond the scope of this article, but it is important to have an appreciation of these intervals in evaluating the importance of a study, as they express the bounds of the ability to truly identify a relationship. A statistical parameter that indicated a three-fold increase in disease from a particular exposure with confidence limits of 2.5 to 3.5 is more statistically meaningful than another statistical parameter indicating a 10-fold increase in disease if the confidence limits bracketed one. By bracketing one, it is possible that there is no effect at all.

One final global consideration with all epidemiological studies is the potential for an association to appear to exist, but it is only due to confounding effects. The easiest way to explain confounding may be by example. In the study of the causes of lung cancer, researchers would have found an apparent association between carrying a butane cigarette lighter and lung cancer. Those carrying a butane cigarette lighter are more likely to have lung cancer. But that relationship is due to confounding, not to a cause-and-effect relationship, because carrying a cigarette lighter is a confounding association with the true exposure of cigarette smoking. Confounding is a situation where there appears to be a statistically higher-than-expected association, but this association is due to a collateral condition, and is not the true condition initiating the cause-and-effect relationship.

Industrial Hygiene Considerations for Metalworking Exposures

The physical state, characteristics and mobility of chemicals in the workplace can significantly change their potency, absorption rate and the ability to quantify these chemicals in an environment. While most of the dose, or amount absorbed, from exposures to metalworking fluids appear to be from airborne materials, skin and gastrointestinal exposure may also play a role. The industrial hygienist needs to be aware of these different routes of exposure and quantify them as necessary.

However, even the singular route of airborne exposures may be difficult to measure or “retrospectively” estimate due to such things as metalworking fluid droplet size, whether or not the material remains a liquid or a vapor, and how the chemicals may have changed due to the heat, pressure and speed of operation of the associated metalworking activity. The application of a metalworking fluid to a grinding operation may generate greater airborne concentrations of contaminants than that produced from a press operation, and depending on temperature and air movement, some materials may remain droplets or turn to a vapor.

Exposures to droplets versus gas vapors may result in different absorption rates and, hence, different doses.

Additionally, exposures may not be solely from the original constituents of the metalworking fluids, as biological contamination of these metalworking fluids may expose workers to bioaerosols, mycotoxins, endotoxins and other biological allergens.

Information about air-cleaning devices that have been identified as being in use during past historical exposures often is not sufficient to determine their in-place collection efficiency and recovery rate. Collected oil droplets may result in revolatilization of certain chemical components, and filter media may have acted as a media for fungal and bacterial growth.

In many of the epidemiological studies, there is a need to have some measure of the dose based on information about the concentration and form of the contaminant. These measures are often made by industrial hygienists, and it has become more important in recent studies to better quantify these exposures.
Recent studies have attempted to re-establish the true chemical composition and levels of exposures from metalworking fluids used in the past. The following is a brief chronological sampling of examples of some of the early landmark studies and the variation in findings.

Ely (1970) reported increased mortality, multiple health symptoms, and decreased respiratory function for workers occupationally exposed to oil mist. His work profiled these health effects in conjunction with other risk factors such as smoking for as many as ten job categories.

In the late 1970s, Decoufle (1978) reported that his study results of approximately 2,500 workers “... suggested that occupational exposure to soluble and nonsoluble cutting oil mists during various metal machining processes does not pose a health hazard in terms of respiratory cancer... but may be associated with certain forms of gastrointestinal cancer.”

In 1981, Jarvholm studied the cancer morbidity pattern among 788 men with at least five years’ exposure to oil mist and found no statistically significantly elevated risk, but acknowledged that the incidence of cancers was too small to allow a sophisticated subdivision to make more meaningful evaluations.

The toxicity of lubricating oils was presented in a paper by the same name in 1986 (Warne) and concluded that “lubricating oils made from properly refined mineral oils exhibited relatively low toxicity... however, even when new oils are free from toxicity, hazards could develop as a result of degradation and/or contamination during use.”

Oil droplet size affects dosage and the ability to absorb the contaminant. In 1986, Menichini reported an order of magnitude in variation in the droplet diameter and different droplet size distributions for various workplaces. For example, he reported that droplet sizes for mineral oils were less than 5 microns, whereas the dominant diameter for synthetic fluids were greater than 10 microns. This type of finding is important as absorption rate and routes may change based on droplet size.

Pederson (1995) studied the proportions of polycyclic aromatic hydrocarbons (PAH) in metalworking fluids (a component correlated with carcinogenic activity) and found increased levels of PAH with recycling of the oil.

Cohen (1995) found that metalworking fluids containing certain biocides may release excessive levels of formaldehyde, a known carcinogen. NIOSH, OSHA and EPA have suggested or have limited the use of such materials over the past two decades.

The research of Woskie (1996) indicated that used metalworking fluids would contain not only microbial-active components, but also microbial produced endotoxins that are known to be harmful. It is also known that many fungus produce and release highly toxic mycotoxins.

Bardin (1997), Holcroft (1997) and Reeve (1997) report on cancers, asthma and hypersensitivity pneumonitis, respectively, for automotive metalworkers exposed to various metalworking fluids.

The result of these observations and studies leads in the direction of increasing knowledge and appreciation that metalworking fluids (as a group of often very distinct chemicals), and the metalworking industry (with drastic differences in metalworking fluid use and mist generation) do appear to present an increased risk of adverse health effects for workers.

References


Cohen. “A Study of Formaldehyde Exposures from Metalworking Fluid Operations Using Hexahydro-1,3,5-Tris...” 

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Application of Human Factors Concepts in the Healthcare Industry

By Mark Monroe, R.N., M.S., CSP, and Suzanne Graham, R.N., Ph.D.

Awareness of the importance of attitudinal, interpersonal, cultural and other nontechnical factors in the achievement of safe outcomes in healthcare is growing. Interest in the applications of human factors approaches to medical care is high. The aviation industry has dramatically improved its safety record over the past 20 years through the design and implementation of a training program widely known as “crew resource management” (CRM). CRM is based on identifying and dealing with human limitations through skills such as teamwork, communication and situational awareness skills. A growing body of evidence suggests that the application of CRM skills to healthcare may measurably improve patient safety.

This article demonstrates the successful adaptation of human factors and CRM skills to the healthcare industry. It discusses the “burning platform” (1999 IOM Report) that readied our organization to reach outside of healthcare and the subsequent partnership with aviation through the University of Texas:

- step-by-step process of designing and implementing human factors interventions across a large, integrated healthcare delivery system (including tools);
- key factors needed for successful implementation;
- current human factors projects within our organization;
- weaving of human factors/CRM into the fabric of the organization;
- research necessary for wider acceptance of human factors approaches in healthcare.

**Medicine—A High-Consequence Industry**

Human error is inevitable. A 1999 IOM report estimated that 98,000 patient...
deaths occur each year as a result of medical error. We know why error occurs—humans have limitations. We are bounded by limited memory, constraints in the ability to process multiple demands, stress exacerbated fixation on task, and human physiological and psychosocial needs for sleep, nutrition, safety, esteem and belonging. These limitations are magnified by poor group dynamics, cultural differences, unrealistic attitudes, experience and other issues such as staffing and work environment.

Delivery of medical care involves the integration of many people in many roles within a complex and ever-changing environment. The players within the healthcare delivery team come from a broad scope of experiential, cultural, gender, training and role expectations. Layer in great power distances that result from a hierarchical culture. Finally, add a rapidly changing technological and innovative environment that challenges care providers to adapt to new equipment and procedures. The result is a highly fluid and complex care environment that sets people up for error.

Complicating the matter is the culture of silence in which healthcare operates. Error has historically been viewed as a direct reflection on competence. The belief was that good doctors, nurses and technicians don’t make mistakes. If we can learn one thing from aviation, it is that everyone is fallible. Even the best pilots have committed error with tragic results.

For example, in 1978, United Airlines Flight 173 was flown into the ground as the crew fixated on a landing gear light. The plane ran out of fuel. The co-pilot knew the plane was out of fuel. The voice recorder had nonspecific “hint and hope” comments such as “there’s not enough.” The captain, an expert pilot, trainer and designer for United, had a reputation of not being a team player. There was nothing wrong with the gear; “controlled flight into terrain” is FAA’s terminology for crashing a perfectly good airplane. Scenarios like this play out all the time in healthcare. Healthcare calls them “failure to rescue” sentinel events.

So how can we reduce the opportunity for error or reduce the impact of error when it does occur? At Kaiser Permanente, we are embracing the study of human factors as one approach to improve patient safety. The focus is team communication.

Human factors is a broad science that deals with many factors influencing human performance. These factors include the physical environment, task characteristics, individual characteristics, and organizational or management systems. Of the broad spectrum of possible interventions, why start with team communication?

In 2000, the partnership between the University of Texas and Kaiser Permanente began when safety experts within Kaiser Permanente noted the similarities between aviation and medicine through the work of social psychologists, Bob Helmreich, Ph.D., and J. Bryan Sexton, Ph.D. A key area common to both disciplines was communication.

Furthermore, the Joint Commission on Accreditation of Healthcare Organizations studied sentinel events over the five-year period 1995 to 2002. Communication breakdowns remain the primary root cause of more than 60 percent of the 2,034 sentinel events analyzed. Most sentinel events (75 percent) resulted in a patient death. Events that could be considered sentinel in the airline industry also have a high correlation with communication issues.

Root-cause investigations of significant events usually reveal that someone on the care team had the information needed to mitigate error, but the communication did not occur to prevent the error from becoming consequential. Active interteam monitoring (supervisory observation), establishing a structured communication tool and setting an environment that is amenable for those with the information to speak up is key to better outcomes.

Additionally, active supervisory observation has been found to trap approximately 90 percent of error before becoming consequential (Morey 2002; Miller, et al 1984). Effective teams respond quickly with effective countermeasures to evolving threats to patient safety.

Finally, a growing body of evidence links improved team collaboration with reduced risk—adjusted mortality, length of stay, nursing turnover, reduced burnout and improved job satisfaction (Sexton, et al).
adopt SBAR as the physician is less likely to “tune out” the narrative noise and accept the nurses’ input appropriately. As nursing and ancillary personnel are given a voice, they view their role in care delivery as more relevant and collegiate with the physicians.

An example of SBAR in action: Respiratory therapist call physician.

Situation: “Dr. Smith, it’s Cindy in RT, Mr. Jones in 206 is in increased respiratory distress.” Background: “Mr. Jones was admitted for pneumonia two days ago, he has a history of spontaneous pneumothorax. His oxygen saturation has dropped from 95% on 2 liters per minute to 85% on non-rebreather.” Assessment: “I auscultated his breath sounds, they are decreased on the right, he has tracheal shift and is in increasing distress, I think he has a pneumothorax.” Recommendation: “You need to get down here right away, Mr. Jones needs a chest tube.”

Assertion is built into the model as the SBAR communication model is established as the norm in team training as the expectation of how situational changes are communicated.

Another component of the tool kit is critical event team training (CETT). This involves monitored (videotaped) simulation of realistic and challenging scenarios developed from events in a facility’s risk files. This has proven effective in stable care delivery teams with low staff turnover. CETT appears to be less effective in teams with high turnover and a transient workforce as the benefits of developing interteam collaboration and trust are lost with the loss of members exposed to CETT. Collaborative skills and performance are debriefed. The video and subsequent debrief is held confidential to the team. CETT provides a safe environment to practice human factors skills and build team collaboration.

**Project Selection & Success**

Several factors are key to project selection and success:

- Limit the scope of the project initially.
- Establish discrete goals.
- Obtain a finite time commitment from team members.
- Employ frequent measurement and feedback.
- Ensure the sponsorship of senior leadership and physicians.
- Build flexibility into project tools and implementation strategy in order to acknowledge local culture and encourage team buy-in.
- Local project site champions and project managers should communicate regularly to share best practices, successes and barriers to implementation.

Within Kaiser Permanente, we have conducted several national and regional conferences for established project leaders and newly developing projects. This networking helps all involved learn which tools seem to work in a variety of settings.

Human factors principles may be adapted and customized to fit a particular clinical environment or team culture. Pilot projects that incorporate human factors skills have been established in ICU, OR, emergency department, procedural units such as radiology and GI labs, ambulatory care, extended care facility transfers, labor and delivery, and nursing units. We have even applied human factors briefing and debriefing tools in projects involving patient safety executive walkarounds.

**Metrics**

In addition to project-specific metrics, we are measuring attitudes about safety through Safety Attitudes Questionnaire (SAQ), a survey instrument developed by the University of Texas.

Why use attitude as a measurement? Attitudes are reliably assessed through validated research instruments and attitude predicts performance and outcomes. Additionally, attitude is malleable, while personality is fixed; training that targets attitude improves subsequent performance. Attitude and culture are linked to observed behavior and performance, and when we aggregate attitude scoring, this reflects the climate of a clinical area/organization.

**TABLE 1**

| JCAHO Sentinel Event Root Causes 1995-2002 |

<table>
<thead>
<tr>
<th>Percent of Cases</th>
<th>Communication</th>
<th>Orientation</th>
<th>Patient Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
</tbody>
</table>

Significant results from our human factors interventions include improvements in nurse recruitment and retention, safety and teamwork climate, and job satisfaction. In addition, the team reports perception of decreased workload (although the department census rate remains the same) and the perception of decreased operating suite turnaround time. Many anecdotes of error trapping and mitigation from improved team communications have been reported. Both pre- and post-project administrations of the SAQ are administered. Results are benchmarked versus 437 implementation sites as an internal quality measure.
Next Steps

The success of the pilot projects resulted in an internal mandate to transfer these practices broadly throughout the organization with particular focus on invasive procedural units and perinatal care. We continue to explore the full potential of these tools in various clinical settings. Tools are being refined and adapting for multiple media and training techniques. In 2004, an OR research project, “highly reliable surgical teams,” will involve modified LOSA or line observation tool by trained observers similar to the work in cockpits by Sexton.

In addition, we are testing the hypothesis that teams with high teamwork and safety climate scores will demonstrate higher rates of trapped error and subsequent declines in adverse outcomes. We are hoping to draw statistically significant correlation of these observational outcomes to the relative scoring on the SAQs.

Pilot projects using technique for human error rate prediction (THERP) analysis and human reliability studies in the observations have been proposed. This would enable us to mathematically model and quantify error rates, a probabilistic risk management tool for patient safety. Continuous observation and oversight is resource-intensive and unrealistic, thus a robust proxy tool for the quality of care delivery must be established, as significant events are rare relative to the volume of care delivered.

We have discussed team communications as a focus area, however, we are moving to expand the breadth of human factors study into design and work environment from an engineering perspective. For example, clinical alarms and anesthesia equipment are being evaluated using a latent conditions checklist. Results of this usability study will be fed back to equipment manufacturers and our standards and sourcing teams (responsible for setting internal standards for equipment for purchasing contracts within Kaiser Permanente). Design templates for new hospital construction are being reviewed to incorporate human factors design into future Kaiser Permanente facilities. Elements of hospital design in consideration include:

- accounting for natural or populational stereotypes—layout of controls and material in a manner congruent with the environment;
- minimizing affordances—behavioral expectancy based on environmental signals. (A familiar example is a swimming pool without a fence. This becomes a predictable trigger—attractive nuisance—for children.)
- engineering anthropometry—ergonomics—to make the care environment user friendly.

Conclusion

To broaden the acceptance of CRM as a human factors teamwork tool application in patient safety, additional measures related to patient outcomes are necessary. As more robust metrics directly correlated to patient outcomes are developed, human factors in healthcare will transform from a novel approach to patient safety to evidence-based practice.

References


Aviation: Linked to Pilot Performance, # of errors, % errors trapped (Helmreich, et al 1986; Sexton and Klinec 2001).


High Speed Rail: Linked to Train Incident and Accident Rates (Itoh and Andersen 1999).


Workplace accidents are events that are generally followed by immense suffering for the affected workers and serious problems for employers. Such events also affect the welfare of workers’ families and reflect on the process and quality of the products, creating additional or indirect costs that sometimes cannot be evaluated. Finally, workplace accidents are undesirable events that deserve corrective efforts from all involved.

Marsh Brazil is deeply involved with this type of problem, even considering that workers’ compensation is carried only by the Social Security under a monopoly. Every year since 1990, they publish a statistical work involving the participation of a significant number of national and multinational companies. These statistics are considered a reference in the Brazilian insurance market.

This most recent study is related to the accident experience of 2002, involving 120 different plants that employed 100,000 workers during the same period, representing an important segment of Brazilian industry.

Marsh Brazil believes this work provides a significant sampling that permits analysis of the evolution of safety results and performance of a group of enterprises—the major part of which presents results considered as positive when compared with the general performance of Brazilian industry. The work also presents a comparison of important general data obtained by clients with those published in the U.S. (which, in few cases, represents a favorable result for Brazil).

This statistical work has been prepared in a proper time, mainly considering the publication of the Law 10.666, published May 8, 2002. This new law determines the application of discounts or penalties in the workers’ compensation rates collected by Brazilian Social Security, depending on the accident results of employers based on the indexes of frequency, severity, cost and performance. The procedures for this new rate condition will be part of a methodology to be published in the near future.

Considering these remarks, Brazilian companies must exert all possible effort to promote the good safety conditions in their plants, not only for cost reduction but also in order to preserve worker welfare and health.

Main Data: Workplace Accident Experience During 2002

This new edition involved 120 plants dedicated to several industrial activities and composed by national and multinational companies. Even considering the variation on the number of participants, we believe that the comparison of the results deserves consideration with respect to the variation of the global results of our work during the last four years.

Regarding the results of 2002, several conclusions deserve consideration, as they involve a total number of more than 100,000 people employed by 120 companies. We believe that several main ones should be highlighted:

• The number of accidents per groups of 100 employees (frequency rate) had a reduction from 1.26 to 1.05—progress being achieved since 2000. Note that a recently published official statistic, related only to the State of Sao Paulo and involving the main industrial branches, informed the record of 62,886 accidents under a group of 2,140,453 workers, therefore representing a frequency of 2.93 cases per groups of 100 workers.

• Among the clients involved in this research, there is record of two fatal cases (among a total of 100,000 workers). This is a positive result and better than that for the previous years (i.e., 0.002 deaths per groups of 100 workers). The noted statistic involving only the State of Sao Paulo registered the occurrence of 657 fatal cases among a total of 2,140,453 workers (i.e., an average of 0.03 cases per groups of 100 employees).

• Even with a small increase on the loss ratio indexes (from 25.42 to 31.04 percent), the same is still considered as acceptable under the private underwriter’s standpoint.

• Some industrial branches are still presenting favorable incidence rates (severity) when compared with the results obtained in the U.S. and published by the National Safety Council (Accident Facts, 2000 ed.). We would call attention to Figure 6 of this report.

However, several negative conclusions that represent a concern must also be noted:

• The average of days lost on each accident continues to increase; this indicates that the severity of accidents is increasing. During 2000, the average was 21.69 days, which increased to 28.57 in 2001 and to 46.35 days in 2002. This represents a 65-percent increase when compared with the previous research.

• The average cost per accident was maintained under the same level (R$ 11,941.14 during 2001 and R$ 11,856.85 in 2002). This cost represents a 90-percent increase over the cost recorded in 2000. We believe this increase was certainly caused by the high number of days away from work. Clearly, this direct cost is too high and deserves all possible efforts for reduction.

• The theoretical loss ratio (premiums paid to the carrier and estimated direct cost of the accidents) rose to 31.04 percent—an increase of almost 20 percent in one year. However, and as noted, this index would be considered acceptable by a private insurance market.

The following discussion focuses on several important details obtained by this research, followed by tables and comments:

• Average of accidents with days away from work, per groups of 100 workers, since 1990;

• Average of days lost per case, also since 1990;

By Sergio Duarte Cruz and Marcelo Campos Forster
• evolution of the average accident cost during the last 13 years;
• loss ratio indexes during the last seven years;
• comparison between incidence rates (severity) obtained by the local researched industries and others of similar activities in the U.S. (published by NSC);
• comparison of frequency rates of the local researched industries and others of similar activities in the U.S. (published by BLS);
• data on the performance per each one of the main industrial groups.

Accidents with Days Away from Work
In 2001, the frequency of accidents per groups of 100 workers showed an interesting reduction. As noted, the index of 2.81 accidents recorded in 2000 dropped to 1.05 in 2002. Several reasons could be responsible for this conclusion, such as a reduction in the number of workers and industrial activities during the last two years. The use of new and modern equipment (which has been noticed during recent surveys) could be another factor.

This frequency reduction is being reported in all industrial segments. A recent official statistic published by a reliable source demonstrated that only in the State of Sao Paulo, the same frequency dropped from 3.22 to 2.93 cases during the last two years.

But as Figures 2 and 3 illustrate, the frequency reduction was not followed by the severity indexes. In other words, frequency dropped, but severity is a concern.

Average Days Away from Work
During 2002, the average days away from work achieved a level of high concern (Figure 2). A loss of 49,040 days due to 1,058 accidents results in an average of 46.35 days per case. This represents a 62-percent increase over the results of our last research (related to 2001), and could be considered as the worst result of the last 13 years.

The reasons for this could not be easily determined. We maintained several contacts with SH&E professionals in Brazilian industry who are normally involved in accident investigation. Based on their information, this situation could be based on the following main problems:
• Initially, the high turnover of workers (a consequence of the uncertain market conditions) could be the basic cause. This situation worsened during recent years and as a consequence, new employee training and selection is being neglected. The replacement of skilled workers by newcomers could be the cause for the occurrence of more serious accidents.
• The tendency to use contractors could be another reason. Certainly, some contractor companies are well-organized and provide adequate training and safety supervision for their employees. But many companies that hire contractors do not provide the necessary integration; this is enough for the occurrence of more accidents. A total dedication in training and integration could be a solution for the problem.
• The number of ergonomic injuries continues to grow due to the lack of management regarding this type of exposure. Reliable sources demonstrated that ergonomic injuries are responsible for 30 percent of days away from work. Programs related to the analysis of ergonomic exposures and organization of ergonomic committees will surely help to reduce this problem.

• A large portion of the days lost originate in causes that are not under direct control of the employers, as they are consequences of transit accidents (between the workplace and the employee residence). Generally, such an accident causes fractures and injuries that cause a large number of days away from work—often much higher than other typical accidents. Curiously, this type of accident includes a large number of executives who are involved in car collisions.

The uncertain conditions of the Brazilian economy contribute to the reduction of qualified manpower and cause the hiring of workers under total urgency in positive moments. Also, the economic conditions are responsible for pressure on production, demanding the performance of overtime.

Regardless of the cause(s), the average of 46.35 days away from work per case is not acceptable. It represents serious damage to worker welfare, and affects production quality and costs.

Workplace Accident Experience

Comparison Results
1999-2002

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of industries which participated in the statistics.</td>
<td>120</td>
<td>64</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>Average number of employees during one-year period.</td>
<td>59,091</td>
<td>27,642</td>
<td>49,959</td>
<td>100,450</td>
</tr>
<tr>
<td>Number of accidents with days away from work.</td>
<td>1,240</td>
<td>778</td>
<td>631</td>
<td>1,058</td>
</tr>
<tr>
<td>Total number of days away from work during a one-year period.</td>
<td>33,910</td>
<td>16,878</td>
<td>18,029</td>
<td>49,040</td>
</tr>
<tr>
<td>Number of accidents per groups of 100 workers (frequency index).</td>
<td>2.09</td>
<td>2.81</td>
<td>1.26</td>
<td>1.05</td>
</tr>
<tr>
<td>Average of days away from work per accident.</td>
<td>27.34</td>
<td>21.69</td>
<td>28.57</td>
<td>46.35</td>
</tr>
<tr>
<td>Number of fatal cases.</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total cost of all accidents during one year (Theoretical cost – compensation + medical/hospital costs).</td>
<td>R$ 9,811,415.00</td>
<td>R$ 4,844,124.15</td>
<td>R$ 7,534,857.09</td>
<td>R$ 12,544,551.01</td>
</tr>
<tr>
<td>Average cost of each accident (theoretical).</td>
<td>R$ 7,912.43</td>
<td>R$ 6,226.38</td>
<td>R$ 11,941.14</td>
<td>R$ 11,856.85</td>
</tr>
<tr>
<td>Value of premiums paid to the carrier (Social Security).</td>
<td>R$ 30,911,962.00</td>
<td>R$ 12,365,387.36</td>
<td>R$ 29,639,278.49</td>
<td>R$ 40,409,633.96</td>
</tr>
<tr>
<td>Theoretical loss ratio (premiums paid and accident cost).</td>
<td>31.74%</td>
<td>39.18%</td>
<td>25.42%</td>
<td>31.04%</td>
</tr>
</tbody>
</table>

continued on page 22
Average Cost Per Accident
The theoretical average cost of each accident (cases with days away from work) occurred during 2001 and 2002 and is a reason for high concern, as it doubled the cost estimated during 2000. This value is obtained through the division of the estimated total accident cost during the last year (R$ 12,544,551) by the number of cases recorded at the same period (1,058 cases).

From this cost, 70 percent is likely absorbed by the employer, based on the following factors:
• salary related to the first 15 days after the accident (which, in Brazil, is a responsibility of the employer);
• expenses related to first-aid procedures, removal to clinics or hospitals, accident investigation and other administrative costs;
• additional medical/hospital costs, which are often absorbed by employers due to the poor conditions of the Social Security health structure;
• eventual complementation of the salary of the injured worker.

The large increase in accident costs is likely related to the severity rate and also to the reasons already noted (e.g., increased turnover, use of nonintegrated contractors, ergonomic injuries). However, the actual high cost represents a situation that requires all possible corrective efforts.

Average Theoretical Cost Per Accident: By Industry
Figure 4 presents the average theoretical cost per each accident per branch of industry involved in this research. The differences between segments can be justified if the following aspects are considered:
• Accident costs include salary compensation and medical/hospital expenses (direct cost). Therefore, the cost is calculated based on the number of days lost per case, considering the average monthly salary (as reported by clients). Medical/hospital costs are theoretically calculated through the use of factors obtained through the comparison of incidence rates (severity) obtained by participants in this research with those published in the U.S. (in Accident Facts).

• In the case of the electric-electronic industry, the elevated cost could be linked to the high number of days away from work (an average of 41.96 days per case). It was reported that this segment had a large number of transit accidents and ergonomic injuries.

• The lower costs presented by the pulp and paper, tobacco, drinks and food industries are considered remarkable. These segments also reported a favorable loss ratio index.

• The loss ratio index of the metal industry remained at 31 percent during the last two years. Those indexes are more favorable when compared with those of the previous five years. Note that the metal industries represent the major portion of participants in this research (40 of the 120 companies).
Regarding the textile industry, the loss ratio index suffered a substantial increase (from 16 percent in 2001 to 81 percent in 2002). This index is of concern and deserves a deep analysis from employers.

Pulp and paper plants also suffered an increase in the loss ratio index (from 1 to 13 percent)—after five years of constant reduction. However, the 13 percent loss ratio is still a good result under the underwriter’s standpoint, mainly because this industry involves hazardous activities. Note the comparison of incidence rates of the pulp and paper plants in Brazil and the U.S. (Figures 6 and 7).

The chemical, pharmaceutical and plastic industries (grouped in only one segment) presented a satisfactory result. Note that the loss ratio of 11 percent represents a reduction of 50 percent from the previous result; it is also the lowest ratio in the last seven years.

Small changes were registered in loss ratio indexes for several other industrial segments, such as electric/electronics, tobacco, drinks and food. These are likely a consequence of non-typical situations, as they are still situated in levels that could be expected in the Brazilian industry.

Loss ratio indexes have become of vital importance at the moment, as a consequence of the new law, 10.666, enacted May 8, 2003. This law allows Social Security to increase the rates up to 100 percent for the plants that have a poor experience or to provide similar discounts to plants with a good experience. Only this situation justifies the search for better experience in workplace accidents.

It should also be noted that among the 120 plants studied, 33 presented a loss ratio above 50 percent (or a general loss ratio index of 104.93 percent).

These plants reported 619 accidents, with a loss of 37,661 working days. However, 64 plants presented a global loss ratio equal to or lower than 15 percent (a very satisfactory result). Most importantly, 32 plants presented a “zero” loss ratio index.

Incidence Rates: Brazil vs. U.S.

Figure 6 presents incidence rates (severity) obtained by each industrial segment and its comparison with those published in Accident Facts. These mentioned rates represent a reliable parameter for the analysis of experience of an enterprise.

For this calculation, the number of days away from work is multiplied per 200,000 hours; the result is then divided by the number of manhours worked in a one-year period. The incidence rate obtained represents an important support for the measurement of the severity of the accidents occurred.

Some industrial segments presented results highly favorable for Brazilian industries (e.g., pulp, paper, tobacco, drinks, food, electric/electronics, pharmaceutical, chemicals and plastics). However, the remaining types of industries presented results worse than those for similar U.S. industries. Note the large differences in the indexes for metal plants, textiles and electric/electronics.

Incidence Rates: With and Without Days Away from Work

Figure 7 compares the incidence rates (frequency) of Brazilian companies to those published in the U.S. by BLS (2001 rates). For the calculation, the number of accidents (with and without days away from work) is multiplied, with the result divided by the number of manhours worked during one year.

Unfortunately, for this detail of this study, only 55 companies participated, continued on page 24
which informed the record of 3,030 accidents (with and without days away from work).

The results are demonstrated in Figure 7. Regarding this aspect, the following comments are offered:

- The good frequency obtained by the metal industries (Brazilian incidence of 5.30 against 10.3 in the U.S.) is related to the participation of the automotive industry. Note that five car assembly plants of very modern conception participated; they suffered a total of 1,329 accidents during 2002, with a total of 45,914,455 manhours worked. Therefore, this represents an incidence rate of 5.78, only for the researched automotive plants.

- The branches of electric/electronic, pharmaceutical, chemicals, plastics, tobacco, drinks and food presented an incidence rate considered as satisfactory.

- Textile plants presented the worst results in both incidence rates (severity and frequency).

This information will hopefully facilitate benchmarking efforts by firms with Brazilian operations.

We mention the severity rates published by NSC in Accident Facts, 2000 ed. The most recent editions no longer inform this type of rate (only BLS frequency rates are reported). Even considering that the rates are from three years ago, we still consider them a good parameter, as the official Brazilian publications do not report the local average severity rates.

Sergio Duarte Cruz and Marcelo Campos Forster are senior consultant and consultant/safety engineer, respectively, within the Risk Control Dept. of Marsh Corretora de Seguros Ltda., Sao Paulo, Brazil. The department created the statistical tables featured in this article. John Kanouse, Administrator of the International Practice Specialty, a vice president with Marsh Risk Consulting, Morristown, NJ, coordinated the publication of this article in World Focus.

FIGURE 5 Loss ratio by branch of industry (values in percent)

FIGURE 6 Incidence rates (severity) Comparison between Brazilian clients and those published in the U.S. (values in percent)

FIGURE 7 Incidence rates (frequency) Accidents with and without days away from work Comparison with rates published by the BLS (values in percent)
Who Is Protecting the Nation’s Workers?

By Dominic Romano, MS, CSP

So, who is out there in the factories and worksites looking out for the nation’s workers? OSHA? Well not quite. While OSHA writes the standards to assist in protecting workers, these standards only scratch the surface of true safety and health management and expertise. Without a knowledgeable individual in place to manage those standards, as well as to go far beyond them, the regulations and management systems are just words on paper.

The SH&E profession must go beyond OSHA management. OSHA is such a small part of what SH&E professionals must do; therefore, a greater education and skill level is required to truly succeed. The individuals who should be protecting workers are SH&E professionals; however, in many cases you also have what this author terms: the “so-called SH&E professionals.”

So-Called SH&E Professionals

So who are these individuals with the title “so-called SH&E professionals”? Quite frankly, they range from human resources professionals to the person who is the best forklift driver. They have little or no formal safety and health education or actual experience, and work for organizations that interpret safety as complying with OSHA regulations. Some of these companies have decided to give these employees the title of safety manager, safety leader or another title that states this person is the main contact for workplace safety and health.

With little knowledge of occupational health and safety, these people are put into a position to fail. While they may be dedicated and put forth their best effort, they cannot provide the leadership and competent management that an educated, degreed and/or certified SH&E professional can provide. As a result, workers are at a higher level of risk. Why?

Because the so-called SH&E professionals are just managing regulations and are usually not trained to conduct proper safety system management. If you disagree with this stance, then ask yourself the following questions.

1) If I needed surgery, would I go to a surgeon or the best nurse on the floor?
2) If I am going to get on a commercial airliner, do I want a competent, trained pilot or the best flight attendant to fly the plane?
3) If I need a root canal, do I want a dentist to do it or the best dental receptionist?

If you are still questioning this stance consider the article “Who is Performing the Safety Function? The Intersection of Human Resources and Safety,” which was published in the April 2002 issue of Professional Safety. This article presented results of a survey of human resources professionals. Question one asked “Do graduates of human resources programs identify safety functions as a portion of their job accountabilities?” Of the written job descriptions obtained, 46 percent specifically included safety as a job function. Forty-seven percent said that they participated on a safety committee and of those 35 percent said they held a leadership role. In organizations with less than 1,000 employees, 32 percent of respondents stated, “I am the safety department.” Respondents also perceived themselves as “inadequately prepared to handle the safety function,” although most indicated they were well prepared to handle “safety grievances/disputes.”

Graduates were also asked whether they were performing the safety functions as defined by ASSE: 1) identify/evaluate hazardous conditions and practices; 2) develop hazard control methods; 3) communicate hazard control information; and 4) measure effectiveness of hazard controls. Some 43 percent said they were identifying and evaluating hazardous conditions and practices. Twenty-eight percent said they were communicating hazard control information; 19 percent were developing hazard control methods, procedures and programs; and nine percent were measuring the effectiveness of hazard controls.

These results show respondents who say they are inadequately prepared to handle the safety function; yet, a large number of them are performing the most critical elements of occupational safety. This is not right and should not be tolerated by workers in this country nor should laws allow this to occur.

The authors of this article propose that to correct this problem, human resource curriculum should include safety topics. I could not disagree more. To say that the addition of some safety topics would qualify human resources professionals or anyone else to handle workplace safety is like saying a person with a private pilot license could fly a 747 with 400 passengers.

What Should Qualify You as a SH&E Professional?

Some attempts have been made to identify what qualifies a person to be an SH&E professional. Let’s look at one of these attempts: the ANSI Z590.1.

Proposed ANSI Z590.1 Standard

The proposed ANSI Z590.1 standard has the objective to set minimum standard criteria to be used in recognizing SH&E professionals, SH&E practitioners, and safety technicians and technologists as being qualified to practice in the SH&E profession. The proposed standard states that an individual needs to meet only one of six criteria to qualify as a SH&E professional. These criteria:

1) Possess certification or an interim certification designation from a nationally recognized professional certifying body.
2) Possess a license in the safety discipline or safety engineering from a federal,
state or local body controlling/issuing such licensing and pursuing ongoing professional development; or possessing registration as a professional engineer from a federal, state or local body controlling/issuing such licensing, meeting prescribed professional safety experience criteria and pursuing professional development.

3) Possess a high school diploma and 10 years' documented professional safety experience in accordance with prescribed criteria, and pursuing professional development.

4) A bachelor’s, master’s or doctoral degree in safety from an accredited safety degree program, in accordance with prescribed criteria, and pursuing professional development.

5) A bachelor’s, master’s or doctoral degree in safety, engineering, or the physical sciences from an accredited college or university, 18 months' professional safety experience in accordance with prescribed criteria, and pursuing professional development.

6) An associate’s degree in safety or any bachelor’s degree from an accredited college or university, five years’ professional safety experience in accordance with prescribed criteria, and pursuing professional development.

The standard does not attempt or intend to prevent the knowledgeable SH&E practitioner from practicing the profession, nor does it require certification or licensing. My question is why not? Why should the SH&E profession be held in any less esteem than other professions? You need a medical license to practice medicine; a person may be extremely knowledgeable about the medical field and pursuing further education, yet s/he is prevented by law from practicing medicine. Some may argue that comparing the medical field to safety is irrelevant, but I would ask you why you hold our profession at a lower level. Do we not provide a technical skill and service? Does our profession not require specialized training and the implementation of that training with the workplace? Do the workers of this country deserve any less with regard to protection at the workplace?

The Solution
In my opinion, the solution to this issue is to take a lesson from our colleagues in the U.K. Under the Management of Health and Safety at Work Regulations of 1992, all U.K. employers should have available to them a source of competent safety and health advice. This can be provided in the following manner:

1) Full-time safety adviser(s). Normally only where:
   • the concern is large enough to support them;
   • the degree of risk warrants it.

2) Part-time appointment.
   - part of a dual role for an existing employee;
   - appointment of a part-time consultant.

3) Retained consultant.
   - To provide:
     • an agreed number of days advice;
     • advice on demand at an agreed fee.
   The law has teeth in requiring that the employer must ensure that the person appointed is competent in relation to the advice being given. Competence can be as follows:

Full-time safety adviser and consultant
To be qualified in safety and health, this person must:

- a) have a university degree in occupational health and safety; or
- b) have passed Part II of the National Examination Board of Occupational Health and Safety (NEBOSH) diploma examination;
- c) having a number of years practical experience in the field;
- d) a full corporate member of IOSH;
- e) a registered safety practitioner with IOSH;
- f) a registered Member International Institute of Risk and Safety Management (MIIRSM) with the British Safety Council.

Part-time appointment
- in high-risk premises
  - a) qualified to the same level as a full-time appointee;
  - b) have passed Part I of the NEBOSH Diploma examination;
  - c) have some years practical health and safety experience.
- in lesser-risk areas
  - a) having passed the NEBOSH national general certificate examination;
  - b) familiar with the work area.

- in low-risk premises
  - a) have passed the NEBOSH National General Certificate examination;
  - b) have obtained the IOSH “managing safety” certificate;
  - c) familiar with the work area.

Where professional consultancy is selected, the employer should check that the practitioner has the following:

- a) necessary degree of knowledge;
- b) necessary expertise;
- c) sufficient facilities to provide the appropriate level of advice.

In this author’s opinion, the U.S. government should adopt a similar law requiring people who perform in the safety and health function to be competent. This can be done with requirements of education by getting a degree in occupational health and safety; current BCSP examinations covering the occupational health and safety technologist (OHST); associate safety professional (ASP); and certified safety professional (CSP); as well as the certificate programs offered through professional safety organizations.

The goal of advancing our profession will never be realized as long as the requirements for being a SH&E professional are poorly defined. Without these requirements written into law and enforced, a key question will remain. “Who is protecting our nation’s workers”?

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Serious injuries or fatalities involving trenching or excavation activities have become common news items lately. I was asked to comment on a recent fatality that made the news in a dramatic way. All injuries and fatalities in trenches and excavations are important and tragic. Loss of life or disabling injury are common results of poorly planned and controlled trench and excavation projects. Mining operations are not immune to these hazards. Ground control is a significant part of mining whether underground or aboveground. Annually, the construction industry experiences the most trench-related fatalities. In 2002, approximately 27 workers lost their lives in excavations and in trench fatalities. Figure 1 (pg. 4) was taken from the Bureau of Labor Statistics website in a data query.

OSHA recently revised Subpart P. Excavations, of 29 CFR 1926.650, .651 and .652 to make the standard easier to understand; to permit the use of performance criteria where possible and to provide construction employers with options when classifying soil and selecting employee protection methods. Will this help? I fear it may not. As Figure 1 shows, the numbers of fatalities are approximately the same year after year. We should see some change slowly indicating fewer and fewer fatalities. We do not and that is alarming. Why do the same number of workers die year after year? In my opinion, enforcement and good rules do not change the fact that construction employs many young workers who often have little experience and almost no formal training. Until we improve the levels of knowledge and teamwork inexperienced workers with experienced mentors, this number will remain static.

This article identifies the needs of the trenching industry, attempts to identify some of the people, discusses soil hazards and offers direction to the inexperienced. What are the issues that cause these large numbers of injury and loss of life?

The dynamic nature of the workforce causes many of the problems. Employers are faced with finding workers who are skilled in identifying soils and knowing the hazards associated with different soil combinations and conditions. Workers are often young with little formal training. They depend on the employer to provide them with the knowledge to develop skills quickly. This is virtually impossible. Skills needed to identify soil, soil types and combinations of soil types are learned by hands-on experience. Employees can learn how to type soil and employers can give them cookbook solutions, but the real world is not scripted and the subsurface encumbrances are often poorly identified at best.

The workforce must properly identify the properties of soils, know what the best combination of shoring, sloping and/or trench boxes will protect workers and how to use them effectively. The Excavations Standard identifies soils by soil properties and strengths. It takes time to develop the skills to effective and consistently type soil. The standard requires a competent person to be present and to have orchestrated the protective safety systems to address the site conditions.

OSHA categorizes soil and rock deposits into four types, A through D:

A) **Stable Rock** is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or sandstone. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.

B) **Type A Soils** are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of Type A cohesive soils include: clay, silt clay, silt loam, clay loam and, in some cases, silty clay loam and sandy clay loam. [No soil is Type A if it is fissured; is subject to vibration of any type, has previously been disturbed; is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or has seeping water.]

C) **Type B Soils** are cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa), but less than 1.5 tsf (144 kPa). Examples include: angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; and layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).

D) **Type C Soils** are cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping and submerged rock that is not stable. Also included is material in a sloped, layered system where the layers dip into the excavation or have a slope of 4H:1V or greater.

E) **Layered Geological Strata.**

continued on page 28
soils are configured in layers, for example, where a layered geologic structure exists, the soil must be typed on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, for example, where a Type C soil rests on top of stable rock.

My preferred way to type soil is by its constituents. What are the typical ingredients of soil? The following is a good start on identifying the soil type and combination.

Humus (organic) is the dark, moist layer found on the top of a soil profile. This is because it is made up of dead and decaying organic matter. It is fertile in that the decay process adds nutrients to the soil that plants soak up. It has little value when considering strength of the soil and can act as a lubricant when combined with water.

Gravel contains highly visible rock particles or pebbles. Particle size is anything larger than 2.0mm. Gravel can be angular or rounded like river washed pebbles. Glaciers in history traveled over the land crushing everything in its path and formed gravel; rivers then worked on the gravel and rounded the edges over long periods of time. It is easy to see that the shape, size and properties of gravel can affect soil strength and properties.

In terms of texture, sand is made of large particles, 0.02-2.0mm in size. Sandy soil has less than 20-percent silt and/or clay. Water drains through sand very quickly. Sand contained has strength but sand unconfined has little strength.

Silt has particles that measure from 0.004-0.006mm. The grains in silt look like tiny pieces of rock. Silt will generally float on the top of a layer of water and will take time to settle out of the mixture. Silt gives soils some excellent properties and strength, and can also cement particles together to give undisturbed soil stability.

Clay is the material that pottery is made from. In terms of texture, it is made of particles smaller than sand, less than 0.002mm in size. Clay soils are made of at least 30-percent clay particles. Since it is composed of the smallest particles, it will take the longest to settle out of solution. In addition, because of the small particulate size, water tends to puddle on clay-type soils.

I take a small sieve and pass soil through it with a pestle to break up the particles into their smallest parts. Then, I measure two inches of soil into a two- or three-inch diameter olive bottle. I add water to fill the bottle and shake vigorously. This causes component parts to settle out in layers. The layers can be measured, converted into percentage of original material and compared to the chart above. The chart indicates the relative portions of each component that comprise the soil. The percentages of each can be followed to points of intersection on the chart. These intersection points then classify the soil. The competent person then has a very good idea of which soil is present and type it by the standard’s classifications. Trained workers
and supervisors then select appropriate protective measures as identified by the type of soil. This is an accurate way of typing soil, but it takes time for the ingredients to settle out. I also want to point out that soil may have 26 characteristics adding to the types as follows:

Characteristics Summary of Parameters: Soil type contains 26 soil units, and values for water and ice. Soil texture is characterized here as coarse; medium/coarse; medium; fine/medium; fine; ice or organic.

Confused? Imagine a young worker on his/her first job striving to make a good impression. S/he must be teamed with someone willing to stop and explain why we do the things we do when we work in soils. The worker has to encounter different soils and combinations of soils to understand how they will react and how long it will take to have a failure. S/he also needs to experience things that cause soils to fail prematurely. In essence, s/he needs experience and to work in many types of soil.

Many kinds of equipment and methods are used to determine the type of soil prevailing in an area.

Pocket Penetrometer
Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading. The instrument is calibrated in either tons per square foot (tsf) or kilograms per square centimeter (kPa). However, penetrometers have error rates in the range of ± 20 to 40 percent.

Shearvane (Torvane)
To determine the unconfined compressive strength of the soil with a shearvane, the blades of the vane are pressed into a level section of undisturbed soil and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading must be multiplied by two to provide results in tons per square foot (tsf) or kilograms per square centimeter (kPa).

Thumb Penetration Test
The thumb penetration procedure involves an attempt to press the thumb firmly into the soil in question. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A. If the thumb penetrates no further than the length of the thumbnail, it is probably Type B soil and if the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is, therefore, the least accurate of the three methods.

Dry Strength Test
Dry soil that crumbles freely or with moderate pressure into individual grains is granular. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand or silt. If the soil breaks into clumps that do not break into smaller clumps (and the soil can be broken only with difficulty), the soil is considered unfissured unless there is visual indication of fissuring.

Plasticity or Wet Thread Test
This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately one-eighth inch (3 mm) in diameter (thick) by 2 inches (50 mm) in length. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

Visual Test
A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.

During a visual test, the evaluator should check for crackline openings along the failure zone that would indicate tension cracks, look for existing utilities which indicate that the soil has previously been disturbed and observe the open side of the excavation for indications of layered geologic structuring. The evaluator should also look for signs of bulging, boiling or sluffing, as well as signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for signs of bulging, boiling or sluffing, as well as signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for “quick” conditions. In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

Safety in the Trenches
To keep our workers safe in trenches they need to have working knowledge of soils and how to type them. They also need to know what measures work best with each soil or soil combination and what the law...
says is required. They need to have the skills to use equipment and tools to stabilize soils. Lastly, they must know the safety procedures for using trenching and shoring equipment.

The problems are obvious. The solutions are not so easy.

• Train workers to know the standards.
• Train workers to type soils.
• Help workers learn the required abatement procedures for soils after they are properly typed.
• Train workers to use the trenching equipment correctly and safely.
• Team them with workers who are competent and who will explain what is happening and what to do for each condition and variation encountered.
• Provide expert leadership that is willing to take the steps to protect workers and to follow the law.
• Provide equipment and supplies at the site when needed that is appropriate for the soils to protect workers.
• Verify that site conditions have not changed and that air monitoring is performed as required.

Will enforcement help? Fines have never been higher and OSHA's attention to trenches and excavations is at its toughest. For example, the following articles on the OSHA website illustrate that the agency is getting tough.

• 2003 - 12/15/2003 - Warwick, RI, Contractor Faces Nearly $110,000 in Fines for Caving and Underground Utilities Hazards at Rhode Island Worksite.
• 2001 - 05/23/2001 - OSHA Cites Three Contractors for Inadequate Cave-in Protection for Workers at Jobites in Manchester, Portsmouth and Exeter, NH; Nearly $66,000 in Fines Proposed.

OSHA requires compliance officers to investigate any trench they may find in the course of their job. They are to stop and inspect any open trench with personnel working inside of it. Given that directive, it would seem that failing to protect workers would become difficult. However, OSHA does not have the resources to identify all dangerous and unprotected trenches.

Workers and employers must work together to abate these hazards. Providing the best equipment to protect workers does little to protect them if it is not used properly. Workers must also strictly follow employer rules and requirements to use shoring and trenching safety equipment.

**Failures in Trenches & Excavations**

A number of stresses and deformations can occur in an open cut or trench. For example, increases or decreases in moisture content can adversely affect the stability of a trench or excavation. The diagrams on this page show some of the more frequently identified causes of trench failure. Workers must understand how a trench or excavation may fail in order to plan and use appropriate shoring and trench boxes effectively. These examples for identifying the means and methods of trench failure are taken from the OSHA Technical Manual.

**Tension Cracks**

Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench. See the accompanying drawing for additional details.

Sliding or sluffing may occur as a result of tension cracks, as illustrated below. This is typical of Type C soils and soils that have high sand content.

**Toppling**

In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crackline and topples into the excavation. This is a failure that may be precipitated by vibration and/or loading by equipment. Water and soils previously disturbed are a part of the formula for such a failure.

**Subsidence and Bulging.** An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench. This is a typical failure of saturated Type B soils. The weight to the water and heavy soil causes the soil to shift slowly until it suddenly fails.

**Heaving or Squeezing.** Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in this diagram. Heaving and squeezing can occur even when shoring or shielding has been properly installed.

**Boiling** is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a “quick” condition in the bottom of the cut and can occur even when shoring or trench boxes are used.

Unit weight of soils refers to the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 pounds to 140 pounds or more and one cubic meter (35.3 cubic feet) of soil can weigh more than 3,000 pounds. As soil weight approached the weight of a cubic foot of water the soil is more likely to boil or heave. I have witnessed vertical cave-ins. The bottom of the excavation suddenly rushes upward engulfing anything in the excavation.

In summary, training, tooling and planning are the weapons to eliminate trench and excavation fatalities. Workers must also have the discipline to follow all rules and requirements. Taking a short cut is always a quick way to become a tragic statistic.

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Lightning is the most under-recognized weather hazard. It is the second-leading cause of storm deaths in the U.S., killing more people than tornados or hurricanes (Curran, et al 1997).

Lightning also inflicts lifelong severe injuries on many more (Cooper 1995; Andrews, et al 1992).

The U.S. meteorological community recently placed more emphasis on lightning safety. The National Weather Service began an annual Lightning Safety Awareness Week in 2000, which is now held annually during the last full week of June (www.lightningsafety.noaa.gov).

The two main U.S. professional meteorological societies, the American Meteorological Society and the National Weather Assn., approved lightning safety policy statements in 2002 and 2003, respectively. Fortunately, most lightning casualties (deaths and injuries) can be easily, quickly and inexpensively avoided through a few easy-to-follow safety procedures. However, these procedures can be inconvenient, so diligence is required in following them.

Many school activities can put students at high risk from lightning. Figure 1 (pg. 3) presents the distribution of locations and activities that had lightning casualties in the U.S. (Curran, et al 1997). In the U.S., the largest number of lightning casualties occurs in open areas, including areas such as sports fields and playgrounds. This is obviously significant for schools, since they have many activities in open fields: sports, recess, marching band and other outdoor extracurricular activities. The activity with the fastest rising lightning casualty rate is outdoor sports and recreation, which includes school activities. Thus, coaches, referees and leaders of other outside school activities must practice good lightning safety. Support from school management is essential in facilitating this process. Therefore, schools need an effective integrated lightning safety plan. This is especially true for schools in areas with the largest cloud-to-ground flash density (Figure 2), the Southeast, Gulf States, Mississippi and Ohio River Valleys, and the Front Range of the Rocky Mountains (Orville, 2000). However, no place in the U.S. is free from the threat of lightning.

This article updates a similar article originally written for the American Meteorological Society 10th Symposium on Education (Roeder, et al 2001).

Background

Total lightning safety requires four tiers of activities: 1) education, so people are aware of the hazard and know what actions to take when lightning threatens; 2) weather warnings to alert people to take action; 3) protection of facilities and equipment; and 4) mitigation, for when that protection fails. This article focuses on the first aspect of lightning safety, since education is the key to improving lightning safety.

The following lightning safety guidelines are based on the recommendations from the Lightning Safety Group (LSG), which are the best set of guidelines available (Holle, et al 1999). The LSG first formed as an ad hoc group at the 78th Annual American Meteorological Society Symposium on Education and Safety in 1999.
Meeting in 1998 in response to the preexisting lightning safety advice, much of which was often contradictory, incomplete, incorrect or even unsafe. The LSG consisted of 16 lightning experts from many diverse disciplines (Table 1). The diversity of members was important since it included not just lightning science and lightning safety experts, but also representatives from real-world applications with lightning experience who helped ensure that recommendations would be practical. The LSG published six recommendations, which are an important step in overcoming previous shortfalls and in standardizing lightning safety. The National Collegiate Athletic Assn. adopted the LSG guidelines as have several school districts across the U.S. (Bennett, et al 1997). The original guidelines have been widely published and are available at various websites.

**Lightning Safety Guidelines**

The original LSG recommendations are adapted here into five levels of decreasing lightning safety (BAMS 2003; Roeder 2003). These multi-level guidelines are easier to interpret, learn and implement than the original LSG recommendations. Table 2 provides a quick reference guide of the five levels.

While no simple lightning safety procedure can guarantee perfect safety, following these guidelines will help avoid most lightning casualties. The most important principle of lightning safety is that no place outside is safe when thunderstorms are within six miles of your location.

Public entities with recurring outdoor activities, including schools, need to have a lightning safety plan. This plan must be in place, understood and agreed to by all participants before it is needed. Adults must be responsible for the lightning safety of the children entrusted to their care.

**Level-1: Schedule Outdoor Activities**

In any safety procedure, avoiding the risk is best. Schedule outdoor activities to avoid the lightning threat. Plan ahead; watch the weather forecast and know local weather patterns. Forecasts are available from the local National Weather Service office. The website for the forecasts can be accessed at the National Weather Service Southern Region Headquarters by clicking on the desired office on the U.S. map at its website (www.srh.noaa.gov). While the National Weather Service does not issue specific weather warnings for lightning, look for the words “thunderstorm,” “lightning-storm” and “lightning” in the forecast.

**Level-2: “30-30 Rule”**

Use the “30-30 Rule” when outside. When you see lightning, count the time until you hear its thunder. If this time is 30 seconds or less, go inside—immediately. The lightning casualty stories have many cases where people were nearly to a shelter when they were struck; if they would have started even just a minute earlier, they would have been safe. If you can’t see the lighting, just hearing the thunder is a good back-up rule for going inside. With 30 seconds between lightning and its thunder, you are already in danger, so allow enough time to get to safety. This extra lead time can be significant for fast moving thunderstorms. For example, if you need five minutes to get to safety, a storm moving 30 mph will travel 2.5 miles. This means you need 13 more seconds (five sec. per mile) between lightning and its thunder to get to safety. This is nearing the limit at which one can usually hear thunder. So for rapidly moving storms, hearing thunder provides a needed added level of safety.

Wait 30 minutes or more after hearing the last thunder before going outside. This time indoors may feel inconvenient after the storm, but it is vitally important. Most lightning casualties occur after the storm has passed or dissipated. The best shelter commonly available against lightning is a large fully enclosed building with wiring and plumbing (e.g.,

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**TABLE 1**

**Lightning Safety Group (1998)**

<table>
<thead>
<tr>
<th>MEMBER</th>
<th>AFFILIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brian Bennett</td>
<td>Assistant Athletic Trainer, The College of William &amp; Mary</td>
</tr>
<tr>
<td>Leon Byerley</td>
<td>Lightning Protection Technology</td>
</tr>
<tr>
<td>Mary Ann Cooper, MD, FACEP</td>
<td>Lighting Injury Research Program, The University of Illinois at Chicago</td>
</tr>
<tr>
<td>Ken Cummins, Ph.D.</td>
<td>Vice President Engineering, Global Atmospheric, Inc.</td>
</tr>
<tr>
<td>Ronald L. Haile</td>
<td>Research Meteorologist, National Severe Storms Laboratory, NOAA</td>
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<tr>
<td>Ken Howard</td>
<td>Research Meteorologist, National Severe Storms Laboratory, NOAA</td>
</tr>
<tr>
<td>Richard Kittel</td>
<td>President/CEO, National Lightning Safety Institute</td>
</tr>
<tr>
<td>E. Philip Krider, Ph.D.</td>
<td>The University of Arizona, Department of Atmospheric Sciences</td>
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<td>Lee C. Lawry</td>
<td>Product Manager, Global Atmospheric Inc.</td>
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<td>Senior Loss Control Specialist, St. Paul Fire &amp; Marine Insurance Co.</td>
</tr>
<tr>
<td>John T. Madura</td>
<td>Manager, KSC Weather Office, NASA</td>
</tr>
<tr>
<td>Marcus McGee</td>
<td>President, Quality Protection Systems, Inc.</td>
</tr>
<tr>
<td>William P. Roeder</td>
<td>Chief Staff Meteorologist, 49th Weather Squadron, US Air Force</td>
</tr>
<tr>
<td>Jim VanReek</td>
<td>Science Teacher, Henry W. Eggers Middle School</td>
</tr>
<tr>
<td>Christoph Zimmermann</td>
<td>Safety Management, Global Atmospheric Inc.</td>
</tr>
</tbody>
</table>

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**TABLE 2**

**Quick Reference for the Five Levels of Lightning Safety**

<table>
<thead>
<tr>
<th>LEVEL (best to worst)</th>
<th>BRIEF DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental Principle: No place outside is safe with thunderstorms within six miles</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Schedule outdoor activities to avoid lightning</td>
</tr>
<tr>
<td>2</td>
<td>30-30 Rule (If 30 sec. between lightning and thunder, go inside. While inside, stay away from corded telephones, electrical appliances and wiring, and plumbing. Stay inside until 30 min after last thunder.)</td>
</tr>
<tr>
<td>3</td>
<td>Avoid dangerous locations/activities (elevated places, open areas, tall isolated objects, water activities). Do NOT go under trees to keep dry in thunderstorms.</td>
</tr>
<tr>
<td>4</td>
<td>Lightning crouch (desperate last resort).</td>
</tr>
<tr>
<td>5</td>
<td>First Aid: Call 9-1-1. CPR or rescue breathing, as appropriate.</td>
</tr>
</tbody>
</table>
a typical school or house). Once inside, stay away from any conducting path to the outside. Do not use corded telephones, and stay away from electrical appliances, lighting, electric sockets and plumbing. Do not watch lightning from windows or doorways. In large buildings, inner rooms are generally better.

If you can’t get to a proper building, a vehicle with a solid metal roof and metal sides offers some protection (e.g., a school bus or typical car). As with a house, avoid contact with conducting paths going outside. If parked, close the windows, lean away from the sides, put your hands in your lap, and do not touch the steering wheel, ignition, gear shifter or radio. In large vehicles, like school buses, moving to the center is better. If driving, it is generally considered safer to keep moving, rather than increase the chance of a collision by parking on the side of the road. Convertibles, cars with fiberglass or plastic shells, and open-framed vehicles offer no lightning protection.

**Level-3: Avoid Most Dangerous Locations**

If you cannot get to a proper lightning shelter and have to be outside with thunderstorms in the area, at least avoid the most dangerous locations and activities with the most risk. (Note: It is much safer not to be outside under this situation.) Remember, no place outside is safe when thunderstorms are in the area. Figure 1 provides the percent of lightning casualties versus location or activity.

Avoid elevated locations, either mountains/hills or elevated places, such as some playground equipment. Avoid open areas, including sports fields, playgronds, marching band practice fields and golf courses. Avoid tall isolated objects such as trees, flagpoles, etc. Do not go under trees to keep dry. Avoid water-related activities: swimming (including indoor pools), boating and fishing. Avoid open vehicles like groundkeeping equipment (riding lawn-mowers, tractors, etc.), open construction vehicles, golf carts (even with roofs), etc. Avoid unprotected open buildings such as picnic pavilions, rain shelters and bus stops. Avoid large or long metal structures such as fences and bleachers. A commonly believed myth is that metal attracts lightning. However, if lightning strikes a large metal object by happenstance, the hazardous electricity can be conducted a long distance, increasing the chance of it killing or injuring more people.

**Level-4: Lightning Crouch**

Use this as a desperate last resort only. Remember, no place outside is safe with lightning in the area. If you’ve made several bad decisions and are outside far away from proper shelter when lightning threatens, proceed to the safest location. If lightning is imminent, it will sometimes give a few seconds of warning. Sometimes your hair will stand upright, your skin will tingle, light metal objects will vibrate, or you’ll hear a crackling static-like “kee-kee” sound. If this happens and you’re in a group, spread out so there are several body lengths between each person. If one person is struck, the others may not be hit and can give first aid. Once you have spread out, use the lightning crouch; put your feet together, squat down, tuck your head and cover your ears. When the immediate threat of lightning has passed, continue heading to the safest spot possible.

Remember, this is a desperate last resort; you are much safer having followed the previous steps and not gotten into this high-risk situation.

**Level-5: First-Aid**

All deaths from lightning are from cardiac arrest or stopped breathing from the cardiac arrest. Start CPR or rescue breathing if the person has no pulse or no breathing, respectively. Have someone call 9-1-1 for professional emergency medical care. Use an automatic external defibrillator (AED) if one is available. Continue CPR if the AED will not shock. AEDs only work if the cardiac arrest is a ventricular fibrillation, but not all lightning cardiac arrests are of this type.

**Implementing a Lightning Safety Plan at Your School**

The following advice is based on real-world experience implementing lightning safety plans at schools. It is absolutely
vital to have management support. Without coordination, management might be tempted to hinder these efforts, no matter how well-intended or how well-designed. In a similar vein, involve coaches, referees and leaders of other outside activities in the planning, rather than surprising them with a final plan perceived as being dictated by management. Handouts, posters, brochures, guidelines, etc., can speed the implementation process.

Be prepared for initial disappointing slowdowns. Besides the normal resistance to change, there are many widely held lightning myths perpetuating the mistaken belief that lightning is not an important hazard or that nothing can be done to reduce the risks. One useful argument is that schools often have plans for hazards with much lower probability than lightning—such as tornadoes, hurricanes or earthquakes. Many people do not understand lightning and lightning safety and will be tempted to avoid making a decision by “passing the buck” up the administrative chain-of-command seeking guidance from ever-higher levels. Each level requires re-presenting previous material and re-fighting the same fights again and again, which can be very frustrating. Be fully armed with all the facts and be ready to present counterarguments to lightning myths and other rebuttals. The need to be fully prepared is vital—one mistake can be seized as reason to dismiss.

One of the greatest concerns will likely be legal culpability. In the past, the attitude has been to do nothing. If a lightning casualty occurs, the defense is lightning is a powerful random “act of God,” a rare and pure accident that cannot be prevented. However, if you try to take action and the incident still occurs, you could be sued for poor safety procedures. In short, it is has been perceived that it would be better to let the accident happen, than to take prudent safety precautions out of fear of being sued.

There appears to be a shift in legal attitudes toward lightning. The growing opinion is that we have learned enough about lightning and lightning safety that failing to take reasonable and prudent precautions will make you guilty of negligence and culpable to being sued under that argument. With proper disclaimers in your plan, and education that the lightning risk can be greatly reduced but not totally eliminated, the legal arguments against not taking precautions appear to be weakening.

Do not underestimate the importance of education for students, teachers, coaches, referees, managers, leaders of other outside activities and other staff. Without an awareness of the importance of the lightning hazard, the lightning safety plan could wither from lack of support. Remember that sports are the activity with the fastest rising lightning casualty rate, so it is vital to involve the sports community. Educating the public can also build support for your lightning safety plan, besides being a good public service.

Other Considerations

Other issues related to lightning safety include lightning detectors and notification services, lightning protection and lightning safety education.

Lightning Detectors & Notification Subscription Services

In recent years, inexpensive hand-held lightning detectors have become widely available. Many people are tempted to use these detectors as an objective tool in lightning safety. However, the performance of these products has usually not been independently and objectively verified. In addition, much anecdotal evidence suggests the devices do not always locate lightning accurately or do not detect weak and/or infrequent, (yet still potentially deadly) lightning. Anecdotal evidence of improper use is also prevalent. Therefore, LSG recommends these detectors not be used, or at most be used as a supplement to the 30-30 Rule. Professional-grade lightning detectors are available commercially. These devices perform well, but are too expensive for most organizations.

Fortunately, automatic lightning notification subscription services are a reasonable solution to the gulf between these devices. These services use the data from the National Lightning Detection Network (Murphy, et al 2002; Cummins, et al 1999) to automatically notify you when cloud-to-ground lightning is detected within desired distances of your desired location during a given time. The performance of this network has been objectively and independently verified to provide good lightning detection and location.

A three-phase approach is best, such as notification when lightning is first detected within 15 miles, as a heads-up that lightning is approaching or developing nearby and to review plans and prepare for actions. The next notification is for lightning within a distance that allows enough evacuation time before the lightning is within six miles. The final notification is for lightning within six miles and all outdoor personnel should already be evacuated to safe shelter.

These services will also notify you when lightning has not been detected within your desired distances for your desired time span (typically 30 minutes). This can serve as an “all clear” that outdoor activities may resume with reasonable safety. Notification can be to pagers, cell phones, e-mail, faxes or other designated electronic system(s).

These services are useful since they provide objective decision points. However, there is one key weakness. The National Lightning Detection Network only detects cloud-to-ground lightning, which is only about 30 percent of all lightning. The rest of the lightning is aloft, either in-cloud, cloud-to-cloud or cloud-to-air lightning, which is not detected by the network. A notification service cannot replace use of the 30-30 Rule, which must be used to warn of lightning overhead. Even though the lightning has been overhead, the next flash could be a deadly cloud-to-ground lightning—it is too risky to assume the lightning aloft will continue to remain aloft.

Lightning Protection

Lightning protection can improve lightning safety by decreasing the likelihood and intensity of indoor lightning shocks. The two main forms of lightning protection are: 1) interception by lightning rods or air terminals (a network of one or more overhead wires) and 2) surge protection.

Lightning Rods & Air Terminals

The function of lightning rods/air terminals is frequently misunderstood. They do not attract, repel or prevent lightning, nor do they significantly increase or decrease the
chances of a lightning strike. Rather, they give a preferred point of attachment for lightning that was going to strike within a few tens of yards anyway. The intercepted lightning then follows a metal cable to the ground where it is dissipated in the soil.

Lightning rods/air terminals must be properly installed and maintained to work well. Installation is best left to professional electricians trained and experienced in these devices and the applicable standards. In addition, people inside buildings with lightning rods must still obey the indoor lightning safety rules. The down conductor can induce secondary electric currents in wiring or metal pipes nearby in roofs or walls.

Lightning protection works only as well as its grounding system. Getting a good electrical ground into soil can be surprisingly difficult. Most lightning protection standards require only low electrical resistance. However, the total impedance is what really counts. Impedance consists of both a time-varying inductance term and a non-varying resistance term. Since lightning has very fast rise times, the impedance term is very important. Unfortunately, the inductance term is often ignored in lightning grounding systems.

Impedance of grounding systems can usually be lowered by increasing the surface area making solid contact with the soil. Typical techniques include driving metal pipes deep into the ground or long shallow trenches with the down conductor embedded in conductive concrete. The low D.C. resistance is also important since some lightning has a continuing current after the rapidly varying currents, especially positive polarity lightning, which can be more than tens times as powerful and damaging as normal negative polarity lightning.

Unfortunately, alternative devices claiming to work much better than lightning rods are being aggressively marketed. These devices are known generically as early streamer emission (ESE) and charge dissipation (CD) devices. Independent expert panels and empirical evidence soundly reject these devices, finding that they work no better than traditional lightning rods. Thus, the extra cost of these systems is not justified. These devices are marketed under continuously varying names. In general, beware of any device with claims that they protect an area larger than traditional lightning rods or prevent/reduce lightning.

Lightning protection can help guard against most hazardous and damaging electric current from lightning striking the building from entering. However, it provides no protection from lightning striking external conducting paths leading inside, such as telephone wires, power lines and plumbing. Surge protection is required to help with some of those hazards.

**Surge Protection**

Surge protection against lightning is extremely challenging, given its very high current (~tens of thousands of amps) and very rapid rise times (~milliseconds). No single device can totally provide lightning surge protection, so a series of devices in the proper sequence is best.

Gas discharge tubes are a good first line of defense and can divert much of the lightning current to the electrical ground. However, because they are relatively slow devices, much of the very high frequency current is passed through them.

Bulk electronic components (capacitors, resistors and inductors) can make low pass filters that can dissipate much of the high frequency current, passing only a little current at the highest frequencies. These make a good second line of defense.

High-speed microelectronics can eliminate the remaining small power high-frequency currents. These devices can only handle small currents and must come last in the series of lightning surge protectors. Multi-level surge protection is especially important for delicate electronics, such as school computer labs. Modern electronics are extremely sensitive to electric surges—even just a few volts of sudden overvoltage can destroy microintegrated circuits. Don’t forget to protect modems, which seem to be especially susceptible to electrical surge damage, either because phone lines transmit surges more often and/or an innate sensitivity.

Power companies often offer reliable lightning surge protection at reasonable cost. However, most of these devices provide only the first-line protection that protects electromechanical devices and improves personnel safety. Further surge protection for delicate electronics will likely be needed. Also, these devices obviously only guard against incoming surges on power lines. They do not guard against surges from other paths, such as telephone wires and plumbing.

As with lightning protection, surge protection works only as well as its grounding systems. Grounding systems must also ensure that a common ground is used, to avoid potentially destructive electrical voltages developing in the system. This means all the grounding systems, such as the lightning protection ground, electric power ground, phone and cable grounds, and plumbing must be electrically connected at some point. This is especially important in large facilities such as schools.

Unfortunately, many manufacturers market surge protectors as effective against lightning that cannot handle either its power and/or fast rise times. They may advertise insurance coverage if you experience damage, but the insurance companies declare bankruptcy as soon as a large claim is filed. Or, they may cite Underwriters Laboratory approval, but that just means the devices are not dangerous, not that they are effective. As with lightning interceptor devices, buyers must beware.

**Lightning Safety Education**

Schools can play a vital role in reducing lightning casualties. Most important is to have a lightning safety plan to protect the students and staff during school activities. The Lightning Safety Awareness Week Working Group plans to post a good example of a school lightning safety plan at the National Weather Service lightning safety website in early 2004 (www.lightningsafety.noss.gov). Next in importance is educating students and staff in personal lightning safety so they can maintain their safety when away from school. If all schools proactively taught lightning safety to their students, we could drastically reduce lightning casualties by the next generation. Finally, schools can facilitate public lightning safety education by sponsoring outreach events, perhaps in conjunction with the local National Weather Service office or other meteorologists.

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Other Sources of Lightning Safety Information  
Agencies interested in lightning safety may find the information in Table 3 useful. Educators working with younger students will especially appreciate the downloadable coloring books on thunderstorm safety.

Conclusion

Lightning is an extremely significant, yet far too often underrated, weather hazard. Most lightning casualties are easily preventable by following simple guidelines. Since the most frequent impact of lightning is lifelong severe injuries, it is especially important to protect children. Schools can serve an essential lightning safety role by practicing good lightning safety for their students, faculty, coaches, and staff. This is especially true for K-12 schools, since adults must take responsibility for the safety of children and youth in their care. Schools can also serve a second role in lightning safety by educating their local communities. The Lightning Safety Group recommendations can help improve the lightning safety at our schools.

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Acknowledgments

Mr. Boyd, 45th Weather Squadron, reviewed this paper. Mr. Willingham, chair of the NASA Kennedy Space Center Lightning Safety Assessment Committee, reviewed the section on lightning protection. Dr. Cooper, M.D., emergency room physician and professor at the University of Illinois at Chicago, reviewed the section on lightning first aid.

The Hard Workers’ Compensation Market & the Opportunity for SH&E Professionals in Strategic Planning

By Shawn Adams, Ed.D., CPCU, ARM, PHR, CHCM

Over the past few years, SH&E professionals, risk managers and the business community have seen the skyrocketing costs of commercial insurance. For several years, the market has been “hard,” an informal term when prices are rising sharply and coverage is shrinking. In 2001, the average company saw a 20 percent rate increase in workers’ compensation we alone (National Underwriter, Feb. 26, 2003).

Since this has been going on for several years, many involved in strategic planning in the firm might turn to the safety and risk management community and ask if the end is in sight. While these costs are unfortunate for the firm, the sharp rise in WC rates serves as concrete evidence regarding the indispensable value of safety. Simply put, the firm’s profitability is affected by WC rates, thus evidencing what the SH&E community has been saying for years—that safety is not an option but a requirement for modern business.

SH&E professionals can use these current business events as an object lesson to emphasize the importance of safety. Still, general managers and business owners are generally confident individuals—and confident individuals are usually also optimistic in nature. There is the danger that general management might say the worst has already happened and the firm, although hurt, survived with less than world-class safety. For SH&E professionals to communicate that signs indicate the worst might not be over and that the firm must be ever-vigilant, s/he must not only understand how to prevent losses, but what caused the artificially low WC rates that lulled the business community into a state of safety apathy in the 1990s.

SH&E professionals also need a solid understanding of what caused the market to harden so that these factors can be explained to top management in order to forecast the future and emphasize the importance of stopping losses rather than paying for them in an environment of increasing costs. Will the WC market turn soft again? Can the firm ease up on safety? Looking at the macroeconomic trends and the headlines of major insurance and financial publications, the news does not
appear to be encouraging. (The reader is asked to note that almost all references are from 2003 publications.)

These macroeconomic trends must be understood for proper assessment and predictions by the SH&E professional so that s/he can provide input to top management as a company makes strategic plans that must include safety to control WC costs.

**The Cause of Artificially Low WC Rates in the 1990s**

To understand why insurance rates started skyrocketing, one must understand what macroeconomic trends drive these rates. Generally, five trends are credited for the low WC rates in the 1990s: 1) a booming stock market; 2) low medical inflation; 3) underreserving by insurers; 4) the lack of recognition of the threat of terrorism; and 5) adequate capacity in the insurance markets. If one can understand these five trends, the soft market of the 1990s and subsequent hardening can be understood.

**Stock Market**

Let’s first consider the stock market, because insurers take the cash flow from insurance sales and invest these dollars in the stock market. In the 1990s, stock prices were high. The return on investment in stocks was repeatedly in the double digits, even though the actual productivity gains of the companies did not support such rapidly rising stock prices. Alan Greenspan, chair of the Federal Reserve, warned that the stock market was overpriced due to an “irrational exuberance” as the baby boom generation continued to pour its money into mutual funds through 401k programs (Foust). Even though stock prices increased almost 25 percent between early March and mid-June 2003, the market still stood 35 percent off the Standard & Poor’s 500 index peak on March 24, 2000 (Shell).

One method by which insurance companies measure profitability is the combined ratio, which is a combination of insurer expenses plus claims paid. In 1997, the combined ratio for the property casualty industry was 101.6 percent, as opposed to a combined ratio 120.6 percent for property casualty as a whole during the third quarter of 2001 and 119 percent for WC (Aon). This means that for every $1 insurers took in as premiums in 1997, they paid out almost $1.02; almost $1.21 was paid out in the third quarter of 2001 for claims and expenses.

To understand how an insurer could lose even $0.02 on every dollar of insurance, let’s return to the stock market. Insurers take premium dollars and turn these dollars into “investment income” in the stock market and in other financial markets. As the stock market went from bull to bear, the profits of insurance companies followed. In 1997, “consolidated P/C industry net income” stood at 36.8 percent. During the third quarter of 2001, it had fallen to -8.4 percent (Aon). The stock market has a major responsibility for the hard insurance market, as well as any recovery that might occur.

**Medical Inflation**

Another major reason for sharply rising insurance costs, specifically WC costs, is medical inflation. One need not be a financial analyst to know that medical insurance rates are going up at a double-digit pace while, Greenspan warns of the risk of deflation in the economy as a whole (Waggoner and Shell).

Medical rates are the most expensive component of WC benefits and, unlike disability payments or legal costs, one for which there is no upper limit (Malecki, et al). According to the National Federation of Independent Business, medical costs have now passed taxes as the biggest concern of the business community (Hopkins). With the aging of the baby boom generation and the number of insured individuals in the U.S., can we expect medical rates to improve? In its 2003 “State of Business Report,” the U.S. Chamber of Commerce flatly states that healthcare is nothing short of a “crisis” and one of the top-10 business concerns (Siobhan-Robinson). In the same manner that group medical rates are being directly affected by medical inflation, WC rates are being negatively impacted by rising medical costs. There is no end in sight.

**Underreserving**

Underreserving is another problem. When an insurer receives notice of a claim, it must establish a reserve (set money aside) to pay the expected cost of that claim. During the bull market, however, many insurers underestimated the final costs of reserves; in turn, this boosted their balance sheets and allowed for more money to be put into the stock market.

Now the bills are coming due. According to National Underwriter, the property casualty industry is understated by $20 billion, which will “most likely reduce commercial lines profitability by five to ten percent annually for the next five to 10 years.” If one adds in surprises such as asbestos and mold liability claims, directors’ and officers’ liability due to cases such as Enron and unexpected medical inflation, the underreserving rises to $35 billion (Mogel). It is as if there was a big party in the 1990s and now it’s time to pay the bills.

**Terrorism**

Terrorism is another major concern. Few expected or planned for terrorism in general, especially of the magnitude of Sept. 11, 2001. Estimates of losses for Sept. 11 are in the tens-of-billions, at a minimum. These costs dwarf the costs of all other major disasters, including Hurricane Andrew (Looney). Those events affected all insurance lines, not only in terms of property lost, but also in terms of WC dollars paid out to victims of the attacks. Insurers, caught once and asked to pay big bills for a terrorism loss, are now building the cost for potential future terrorism into their rates.

**Industry Capacity**

Finally, capacity is a concern. To ensure solvency, insurers are not allowed to write policies without assets to pay for potential claims. Insurers can only write as much coverage as the “admitted” assets they have on their balance sheet based on the type of assets the insurer holds, the liquidity of those assets, the line of coverage being written and several other factors. This “capacity” indicates how much money there is in the insurance markets available to write coverage. The lower the capacity, the higher the rates. It is the simple law of supply and demand.

Unfortunately, the capital of U.S.- domiciled property casualty insurers has decreased by more than 15 percent—$52 continued on page 38
What Does the Future Hold?

Although the market is hard, do any signs indicate a turnaround in rates? Unfortunately, while rate increases are slowing down, no strong indicators suggest a turnaround will bring back the low WC rates of the 1990s. To the contrary, headlines from the industry’s publications are negative. For example, the combined ratio for 2002 does not look good. Fitch is a major rating agency in the property casualty industry. Recently, it reported that, although rates have been increasing, the commercial insurance combined ratio for 2002 will be approximately 104.6 percent (Souter). NCCI estimates the combined ratio for 2003 to be 110 percent (Hays), meaning insurers are still losing money despite sharp rate hikes. According to National Underwriter, which quotes Dennis Mealy, NCCI chief actuary, many WC carriers “may need a combined ratio of less than 100 percent in order to return their cost of capital” (Hays). Vincent Dowling, managing partner at Partner Securities, LLC, claims the combined ratios need to be in the “low- to mid-80s” to achieve both insurer profitability and attract investment (Ruquet).

Consequently, negative news, such as 73 insurers being downgraded (National Underwriter, March 5, 2003) and payment to state guaranty funds in 2001 hitting a 15-year high due to insolvencies (Fletcher), abounds. From an insurer and investor standpoint, the crisis is far from over. Therefore, the insured will be negatively affected.

Another reason for pessimism concerning the hard WC market rests with the insurers for insurers—known as reinsurers. Based on their philosophy and financial status, property casualty carriers sell or “cede” part of their business to reinsurers to mitigate their risk and free up working capital. Unfortunately, reinsurers are experiencing the same poor economic results as primary insurers. Reinsurers are facing the same high losses, dropping capacity, underreserving and inadequate rates that affect primary insurers.

For the sixth consecutive year, even after January renewal rate increases went into effect, reinsurers are suffering with no relief in sight (Hodge; Howard). Undoubtedly, these firms will raise their rates, which will, in turn, be passed on to the consumer by the insurance carrier in the form of still higher rates.

Impact Felt Across the Country

Throughout the nation, companies are feeling the effects of this hard market. In California, nearly two dozen WC carriers have become insolvent (Dickerson) and the state insurance plan, the California Insurance Guarantee Assn., recently borrowed $170 million from a fund designated for automobile and homeowner’s claims (National Underwriter, May 16, 2003) to stay solvent. California businesses paid WC rates 69 percent higher in 2002 than in 2000 (Dickerson). All this just 15 years after WC reform had allegedly solved California’s WC problems.

In Ohio, a monopolistic state in which only the state itself can provide WC, the system is also in turmoil. Some businesses can expect to pay “up to four times as much for workers’ compensation coverage starting this summer.” Although the state paid $9.3 billion in credits between 1996 and January 2003, the “weak stock market sapped surplus funds that the Ohio Bureau of Workers’ Compensation used to pay for the credits” (Imperman).

As a result of sharply rising rates, some states are instituting WC reforms. Recently, Texas passed a bill designed to aid the “state’s troubled workers’ compensation” system. This bill would, among other things, allow for more time for insurers to determine the legitimacy of a claim and require the claimant to challenge any finding of maximum medical improvement and impairment rating within 90 days or lose the right to challenge those findings (Mogel).

Florida, where $1.27 is paid out in WC for every $1.00 paid in, recently passed WC reforms. These will modify the criteria for finding an injured claimant as permanently, totally disabled; prevent employees from claiming permanent, total disability benefits if they can perform any “sedentary work within a 50-mile radius of their residence”; and limit attorney fees. Governor Bush is expected to sign the legislation, which is expected to reduce WC rates by 12 percent (National Underwriter, May 28, 2003).

Large states with major metropolitan areas are not the only ones experiencing WC troubles. In June 2003, the West Virginia legislature met in an emergency session. According to Greg Burton, executive director of West Virginia’s Dept. of Worker’s Compensation, the purpose was to pass an emergency WC funding and reform bill that would keep the system from bankruptcy and federal receivership (The Charleston Gazette). Clearly, WC rates are a major problem for businesses and the economies of these major states.

Will the Current “Recovery” Slow—or Cut—Rates?

Although the past few years have been rough, many would point to some positive signs in the U.S. economy and particularly the stock market that could mitigate WC rates. The stock market is up, a tax cut was approved, inflation is low and interest rates are down. While positive, these signs should be viewed with a skeptical eye. Perhaps the situation will improve, but what if it does not? As a recent CNN/Money article pointed out, the Japanese economy has tried the same measures, had rallies and sank right back into the doldrums. “Hmmm, massive fiscal stimulus, a central bank cutting rates to the bone and a policy to weaken the yen. Why does this all sound so familiar?” (Lahart).

Why, as an SH&E professional, should you care about national macroeconomic policy and the comparison with Japan?
Again, the economic policy of the U.S. affects the stock market, which directly impacts the rates insurers charge for their property casualty products. As Senge pointed out, our world is a system, a “framework for seeing interrelationships rather than things, for seeing patterns of change rather than static ‘snapshots’” (Senge 68). Company management sees the “snapshot” of sharply rising WC rates without understanding why. Without this knowledge, optimistic strategic decisions are made—for example, to not invest in safety—laboring under the hope that “WC rates can’t go up forever.”

Of course, these rates cannot go up forever and nobody can predict what the economy will do tomorrow. However, SH&E professionals need to understand the trends affecting rate increases in order to provide top management with input for better-educated strategic decisions. Of course, minimizing losses is a much better alternative than the best cost containment systems, the most advanced risk financing system and all the unfounded optimistic hope in the world combined.

A good example of attempting to predict the future of WC rates is to pay attention to those who specialize in economics and insurance. Based on recent headlines, the future is still very volatile. During a November 2002 meeting of the Risk & Insurance Management Society, analysts from A.M. Best, Moody’s, Fitch’s Ratings and Marsh concurred that the insurance markets are still in trouble. According to panelists during a session entitled, “The Slippery Slope of Rating Downgrade: Will Insurers Writing Your Risks Today Be Around to Pay Your Claims Tomorrow,” reasons include “asbestos, finite reinsurance, loss reserves and the market cycle” (McDonald).

Warnings from the major rating bureaus concerning the state of the insurance market cannot be dismissed or ignored. Another example of how poor the insurance market is involves the “good news” coming from the industry. For example, one survey showed that commercial property casualty rate increases were “stabilizing” because the experienced rate increases were “averaging 20 percent or less during the first three months of 2003” (Hofmann). Another survey showed the markets peaking last fall at 25 percent, although now the growth rate has “fallen” to 20 percent (National Underwriter, June 11, 2003).

Consumers’ view of this good news would likely be viewed less positively than the headlines. The June 11, 2003 National Underwriter article warned that the market will be hard longer “even as the pace of price increases slows.” How long can the average business continue with 20 to 25 percent annually compounding rate increases in its WC bill?

Again, it is important to understand that nobody can predict the future. However, the collective opinion of experts is usually a good indicator. Unfortunately, these indicators are not positive. Yes, the stock market is up. But the Japanese tried the same methods to improve their economy and four times in the past 13 years, the stock market has increased more than 30 percent. Each time, the bubble came back only to burst again within a year (Lahart). Since property casualty insurers make much of their profits from the stock market, this is significant.

All Signs Point to High WC Rates

Other signs indicate a continuing hard market. With baby boomers aging and medical rates eating up most of the dollars paid out in WC, will medical inflation subside and WC costs level out or will the opposite occur?

According to a recent survey published in the Washington Post, group health insurance rates are expected to go up “sharply,” with “average” increases being more than 20 percent and some companies receiving rate increases of 35 percent as the business community braces for “double-digit increases” for the fourth straight year (Brubaker). In the same manner, keeping in mind the role medical costs play in WC costs, WC rates should be expected to increase because of medical costs.

Other signs of a hard insurance market in the future, such as the growth in toxic mold claims and the continuing problem with asbestos liability, should feel more familiar to SH&E professionals and serve as additional indicators of the future. As noted, the past practices of underreserving could affect rates for years to come as insurers try to catch up.

The Only Alternative: Prevent Losses

If the major indicators of the WC market are correct, businesses are in for a tough road and should make appropriate strategic plans to keep losses low in order to ride out the current storm. This is an important opportunity for the SH&E profession. Too many still do not pay attention to the importance of safety based on moral arguments. Now, because of high WC rates, top management has no choice; it must pay attention to preventing losses. Otherwise, many firms will be caught unprepared, as they were for this current hard market.

While the news is not good, it appears that SH&E professionals have an opportunity to prepare for whatever the future might bring. Of course, as noted, step one is not a top-rate cost containment program, a stellar risk financing program or keeping your fingers crossed. A much greater result can be realized by stopping losses to begin with.

References


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Since Sept. 11, 2001, security tops many agendas. In the transportation industry, security is always a critical issue—recent events merely turned up the heat. Security risks come from various sources, so what you need to do for your company depends on the specific type of operation and exposures. Addressing your security problems means more than just responding to a singular threat.

Security risks begin with plain old theft. Theft can be broken down into several categories:

- Is there pilfering from cargo or packages entrusted to you for transportation?
- Is that pilfering from internal (employee) or external sources?
- How about theft of parts and supplies from the garage? These make tempting targets unless you control inventory. And, it’s always possible that cash will disappear as it moves between employees or is placed into what should be secure locations.

Security issues continue with threats to the safety of people who work with and for the company. Workplace violence continues to be a major problem. Worker disputes with managers and coworker conflicts can lead to serious problems, including the violence often reported in the press. And, while rare, armed robberies could occur.

Vehicles are also at risk. If you transport high-value cargo, you know and have reacted to the risk of vehicle hijacking and driver assault. But, in today’s world, the concept of high value has been redefined. To those with bad intentions, hazardous cargo vehicles may be worth more than ever before. But this risk extends beyond these high-profile issues; vehicles have been disappearing for years—stolen while parked or left unattended.

How can these security risks be reduced? Begin by seriously considering the risks faced, and determine how to respond. This process will result in a “to do” list. From this list, you can identify “must-do” items and “might do” items. If possible, do them all. Taking those extra steps means long-term security from real or potential threats and more protection for everyone. While you can’t protect everyone everyday and can’t foresee every risk, you can take some practical steps to lower security exposures.

Following are tips assembled from experience and other sources, including Lancer Insurance, Greyhound Lines, U.S. Dept. of Transportation and the New Jersey Motor Truck Assn. This list is not all-inclusive, nor will all of these ideas fit all businesses.

People Problems
Who you hire, employ and permit access to is also critical. Security screening at ports of entry and government facilities is now the norm, so prepare your organization by considering these security tips used by many organizations:

- If employing non-U.S. citizens, make sure to address country of origin issues and review immigration papers carefully.
- If someone shows many recent or past addresses, use caution.
- Obtain and verify personal references, and check source of the references.
- Institute an employee ID or badge program.
- Photograph and fingerprint all employees and maintain permanent records.
- Permit no visitors into your facility without registration, identification and guest badges.
- Never allow people to roam freely; escort all visitors.
- Train all employees to assist and escort visitors and to challenge outsiders.
- Review vendor personnel credentials carefully and confirm identity with the vendor’s office.
- Complete a criminal background check on all prospective employees.

Protecting Vehicles
Vehicles can disappear or, in the wrong hands, be used as weapons. Many actions can be taken to minimize this threat.

- Drivers should conduct security and safety pre-trip vehicle inspections.
- Check internal and external compartments, storage areas and the underside of the vehicle during the pre-trip inspection.
- Establish a way to inspect a vehicle’s rooftop or top side.
- Secure the keys; never leave them in unattended vehicles.
- Consider installing vehicle electronic access codes instead of using keys.
- Lock all vehicles, every time, including all doors and external access points.
- Watch for signs of tampering; if suspected, inspect the area carefully and call police.
- Paint the company ID and unit numbers on the roof of vehicles.
- Establish a system that makes fire extinguishers recognizable to prevent switching.
- For trucking, use kingpin locks on remotely parked trailers.
- Install remotely operated engine-kill switches, especially on vehicles that transport volatile substances.
- Add communication equipment that works reliably from virtually any point the vehicle is apt to travel to or through.

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Protecting Premises
Security begins at the perimeter; it continues with internal precautions that restrict access to authorized personnel only and concludes with systems that reduce the opportunity and increase the risk of detection for those with criminal intentions.

Consider these suggestions:
- Fence in your yard or property to restrict access.
- Have an entry gate and use it; always lock entry gates during off-hours.
- Add lighting for the yard; few things add more security than illumination.
- Offer secure employee parking separate from secure operations perimeter.
- Control your parts and supplies inventories.
- Utilize closed circuit cameras and video recorders.
- Add guards, guard dogs or patrols for high-value or high-risk operations.
- No one should be permitted to carry high-value or hazardous cargo.

Securing Operations
Dispatchers and drivers need to find ways to reduce security risks. Criminal behavior is often the result of random opportunity, but some criminals carefully observe behavior and seek advantage from the element of surprise.

To help lower risks, consider the following:
- Institute a regular call-in program for everyone who travels outside the premises.
- Insist that the call-in program be utilized by every employee, every day.
- Have a code word or phrase that, if used, is a signal of warning or danger.
- Vary vehicle routes and timing of delivery so predictable patterns are not established for vehicles transporting high-value or hazardous cargo.
- Park only in secure locations, never in isolated or unlit areas.
- Be cautious if new customers are reluctant to discuss commodities being transported.
- Freight carriers should perform credit or business reference checks on new shippers.
- Beware of conversations with strangers who offer inappropriate or detailed information that could be turned against you.
- Teach drivers to stay alert for risky situations and avoid them.
- Doublecheck routing and schedules; ensure that your arrival is expected.
- Be attentive to current events; awareness of trends could help to keep individual events from repeating themselves in your company.

As noted, these are only a few of the many steps you can take to better protect your transportation company, employees and customers. Consider these and network with industry colleagues to come up with the best strategy and tactics to protect your company.

Special Tips For Motorcoach Operators
Companies that transport passengers have the potential of inviting their security threats on board. Special provisions for passenger safety and security need to be considered:
- Create and maintain passenger lists. Require ID for boarding.
- Screen riders before they board for alcohol and other drugs. Try to keep trouble off the coach.
- Encourage passengers to stow packages in baggage areas.
- Match bags to passengers; never allow unaccompanied bags onboard.
- Restrict access to baggage compartments.
- Post signs onboard prohibiting alcohol, drugs and weapons of any kind.
- Train drivers to recognize and prohibit hazardous cargo onboard.
- Train drivers in passenger and threat management skills.
- Instruct drivers to respond to threats and potential hijackers with caution.
- Install an exterior “trouble” light or other silent alarm to alert authorities to onboard problems. Inform law enforcement of the intent.
- Train drivers to summon law enforcement assistance immediately when and where problems arise.
- Disconnect batteries and lock all doors when parking overnight.
- Always keep the entry door closed when stopped or awaiting passengers.
- Line operators should consider discontinuing “flag stops.”
- Avoid stopping to aid distressed motorists; call highway patrol instead.

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