Hydrogen Sulfide: Developing Effective Training

Frank Perry, P.E., CSP, an ASSE Fellow and a former ASSE president, is chair of the Z390 Accredited Standards Committee (ASC) for Hydrogen Sulfide Safety Training and vice chair of the Z490 ASC for Criteria for Accepted Practices in SH&E Training. Greg Smith, CSP, ASSE’s current Region III Vice President, is ASSE’s primary representative on the Z490 ASC. In this interview with staff for ASSE’s Council on Practices and Standards (COPS), they explain how SH&E professionals can best incorporate the Z390.1 and Z490.1 standards into their safety programs.

COPS: Please provide a brief description of your professional backgrounds and of your involvement with the Z390 and Z490 ASCs.

Perry: I spent the past 26 years of my conventional employment with Cameron Iron Works, now Cooper Cameron Corp., in the SH&E field. Since April 2001, I have been an SH&E consultant, primarily dealing with hydrogen sulfide (H₂S) issues. I served on the founding committee for the Z390 ASC and have been chair of the Z390 ASC and vice chair of the Z490 ASC since their inception.

Smith: I am president of Construction Safety & Health Inc. (CSHI) in Austin, TX, and have more than 28 years’ experience in the safety field, working in both general industry and construction environments. I am a primary representative on the Z490 ASC.

COPS: What are the primary concerns SH&E professionals must address in reducing and eliminating H₂S hazards?

Perry: Most H₂S exposures are of an accidental nature. SH&E professionals must ensure that the control systems are adequately engineered so as to reduce accident potential. Additionally, all individuals with the potential for H₂S exposure must be properly trained and supplied with an adequate H₂S warning device and appropriate respiratory protection.

COPS: How do the public and private sectors use the standard, Accepted Practices for Hydrogen Sulfide (H₂S) Training Programs (ANSI/ASSE Z390.1-2006)? Is it cited in contracts and work agreements?

Perry: The Z390.1 standard is an excellent document for use as a training guideline for individuals who might be exposed to H₂S. It defines the process for qualifying an H₂S instructor as well as the required topics that should be addressed in the training. A sample outline for a comprehensive training course is found in Appendix C of the standard.

COPS: What are the major differences between the Z390.1 standard and OSHA’s regulations?

Perry: No specific OSHA regulations relate to H₂S. Z390.1 was developed to supplement the training requirements for OSHA 29 CFR 1910.1200 (HazCom), 1910.134 (respiratory protection) and 1910.120 (HazWOPER) standards. With respect to application, Section 1.3 of the Z390.1 standard reads:

This standard is recommended for voluntary application in occupational settings where personnel have the potential to be exposed to concentrations of H₂S in excess of the Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs) as established by the American Conference of Governmental Industrial Hygienists (ACGIH) in their 2005 publication titled Guide to Occupational Exposure Levels.

COPS: How does this relate to the real world? Are all industries covered/included in the standard? Does Z390.1 work well within other industries, such as construction and maritime?

Perry: It is the committee’s intent for Z390.1 to apply to all industries with the potential for an H₂S release or exposure. No specifics or exclusions are given for any particular industry, and the standard’s requirements easily apply to both construction and maritime operations. Every year, needless H₂S-related injuries, illnesses and fatalities occur within the construction and maritime industries, particularly in confined spaces.

COPS: Section 6 of Z390.1 discusses student competency and qualification, and includes an assessment. However, if a training audience is of mixed experience, how should trainers tailor their approach?
Perry: Instructional materials take students to the most basic level of H₂S safety, then bring their knowledge base up together, regardless of prior experience. The standard allows the instructor to evaluate the students’ understanding of this information through a performance-based mechanism that is a written, verbal or practical evaluation.

COPS: Section 3.12 of Z390.1 discusses engineering controls. What does this mean in regard to certification? For example, if an engineering control is implemented, does it require approval by a professional engineer?

Perry: The purpose of this section is to familiarize the student or user with certain engineering controls that are designed to control or minimize H₂S concentrations on a location or within a given process.

Although these controls may be designed and/or approved by a registered P.E., the intent is to make the student aware of the presence of and rationale for that control. An example might be a specific ventilation system to protect workers or an amine process to remove H₂S from a gas stream.

COPS: Section 7 of Z390.1 discusses different techniques and language/cultural challenges. How have you addressed these challenges in your training? What works well for you?

Perry: When I conduct instructor development courses or the H₂S master trainer course, I emphasize the importance of conducting courses in students’ native language. This is not always possible, and instructors may need to use an instantaneous translator.

Visuals and audiovisuals should always be in the students’ native language as well. If these options are not viable, I make my presentations in English, then work with the students one-on-one to ensure that they comprehend the lessons and to encourage their participation in the classroom.

COPS: How can SH&E professionals best evaluate their worksites to see where Z390.1 applies?

Perry: They can start with the listing of occupations with potential H₂S exposures, which is found in Appendix A of Z390.1. The list is not all-inclusive, but it may initially identify a potential problem. If there is a question about the standard’s applicability or if any concentration of H₂S is found in the process, then one should know that the standard applies. You could also consult with an experienced chemist to determine whether any of the chemicals found in a particular location might generate H₂S if they are mixed together. It can be particularly difficult to work with this type of process.

COPS: Why does the petrochemical industry seem more proactive in H₂S training than other industries? What makes the petrochemical industry unique?

Perry: I think the petrochemical industry is more proactive because it has produced more H₂S-related injuries, illnesses and fatalities than any other single industry. That is not a record to be proud of, but it has driven the industry to examine procedures and practices to help reduce incidents in which H₂S is a causal factor.

The petrochemical industry is unique because its members frequently drill into zones where H₂S is present, then bring the sour crude, sour gas or sour steam to the surface. From there, we try to separate the H₂S through various chemical processes then market the H₂S for other processes or try to dispose of it in an environmentally friendly way.

COPS: H₂S hazards and exposures exist not only in environments with a large-scale breakdown of organic matter, but also in specialized industrial applications, such as coke ovens, paper mills and tanneries. What should SH&E professionals look for when determining whether H₂S hazards exist?

Perry: Again, SH&E professionals can start with the occupation listing in Appendix A of the standard. After that, consulting with an experienced chemist may help identify product streams that could be contaminated with H₂S or could produce the gas should it come into contact with other chemicals. The presence of any concentration of H₂S can produce a potentially toxic environment in several situations.

COPS: Do water retention systems in the mining industry present H₂S exposures?

Perry: H₂S is readily soluble in some fluids, such as alcohol, liquid petroleum hydrocarbons and water. If the water used in mining operations is subjected to H₂S gas, it is very possible for that water to become contaminated with the gas.
**Perry:** I personally feel that most H2S-related fatalities occur within a confined space. The Z390.1 standard does not specifically mention confined spaces within the body of the standard, but the instructor development courses focus on confined spaces when we discuss safe work procedures. For SH&E professionals, Z117.1 is a natural companion document with Z390.1.

**COPS:** Can ordinary monitors be used to sample for H2S? Should sampling equipment be calibrated or is a standard bump test prior to use sufficient? Before sampling a confined space with potentially high levels of H2S, should the space be ventilated?

**Perry:** Every monitor and detector has a specific purpose. Only those specifically designed for H2S gas detection or monitoring can be used for that purpose. Each piece of detection equipment should be calibrated in accordance with the manufacturer’s recommendation. Regarding the standard bump test of function testing, my personal recommendation is to bump test your own detector before each use, no matter whether that means each day, each shift or each week. You must have complete confidence in your protective equipment when working in a potentially toxic environment.

If you sample a confined space for H2S, I suggest that you sample that space before entry to determine whether a hazard exists at that point and to determine the gas’s concentration. After ventilation, the space should again be monitored to ensure that the hazard has been mitigated. If that space must be entered, I recommend continuous monitoring for the gas.

**COPS:** What do you say to clients who believe their site does not have an H2S problem or has only small amounts of H2S?

**Perry:** We frequently address this issue, and it usually involves a workplace where the client does not want to deal with the additional safety measures that would be required if H2S were present in significant concentrations. In my classes, I demonstrate how an uncontrolled release of a “relatively safe” level of 8 ppm of H2S can produce a deadly work environment. H2S may be considered a self-evacuating gas. It is heavier than air, will displace air, particularly in a confined space, and will have the natural tendency to greatly increase its concentration.

**COPS:** Some H2S instructors are unaware of or ignore the 3-year training refresher recommendation in the Z390.1 standard. What should clients look for when selecting a training provider? Is a certification card or certificate granted against Z390.1 for the trainer? How can the client ensure that a trainer is knowledgeable in the standard’s current requirements?

**Perry:** As we prepare H2S master trainers, we recommend that they fully review the 3-year refresher issue with their instructor-candidates. For my own instructor-candidates, I personally issue an instructor recertification card that shows an expiration date of 3 years after the completion of their instructor development course. This serves as a reminder to the instructor that retraining is required.

If clients are knowledgeable in H2S principles, they can ask when the instructor’s training took place, whether s/he attended a refresher course and a few questions such as, what is the immediately dangerous to life or health (IDLH) value of H2S? or what is the current TLV of H2S? or what is the NIC as proposed by the ACGIH?

**COPS:** What should users look for in a trainer, certification or level of experience?

**Perry:** While the standard recognizes that instructors/trainers are not required to have any formal H2S instructor development training, such formal training is strongly recommended. Instructors should have completed an appropriate H2S train-the-trainer development course from a recognized or accredited training organization. These instructors must conduct a minimum of two H2S classes each year and should attend an H2S instructor refresher course every 3 years.

**COPS:** Although a training assessment is included in the Z390.1 appendix, a hazard assessment is not included. How do you help clients with training and hazard assessments?

**Perry:** A training assessment is mentioned in Appendix C of Z390.1, but a full assessment is not detailed there. I recommend to my instructor-candidates that they assess the training event in a written, verbal or practical method. When helping clients with a hazard assessment, instructor-candidates’ operation personnel should work closely with SH&E personnel to sample for any concentrations of the gas, assuming it might be present at very high levels. Any processes that may produce H2S should be closely monitored to ensure that engineering controls, if present, work as intended.

Individuals performing the monitoring must be properly protected with supplied air respirators while sampling these unknown concentrations. Unknown concentrations of H2S must be considered IDLH until sampling and measurements show otherwise. The buddy system should be used during the sampling process, and if IDLH values are detected, then standby rescue personnel must be rigged and ready to assist those workers should an emergency arise.

**COPS:** How should PPE issues be addressed in H2S training?

**Perry:** PPE issues are most important for H2S workers. They must understand that H2S has poor warning properties—it kills the sense of smell and is heavier than air. You may think it is gone when you can no longer smell it,
I would also require that the various employers working on a site provide an outline of the specific H₂S course their employees attended, along with a short curriculum vitae of the course instructor. It would then be the SH&E professional’s job to compare that outline with the Z390.1 requirements to ensure that employees are properly trained. The SH&E professional for a particular worksite should conduct a follow-up training event that addresses site-specific issues which reinforce or supplement the worker’s initial H₂S training.

**COPS:** Training all employees of a company can be a daunting task. How can a standardized directional template such as Criteria for Accepted Practices in Safety, Health and Environmental Training (ANSI Z490.1-2001) affect employee training?

**Smith:** When used as a template for development, the standard can create a reproducible model for standardizing company-wide training. Development will follow the same vetting process regardless of the specific topic. This helps ensure that important components relative to an effective training event are implemented every time a training event occurs.

**COPS:** Can the Z490.1 standard be used as a tool when accessing third-party training content for a company?

**Smith:** Absolutely. By using the development measurement process as an evaluation of a program, a company can gain significant insight. For example, if the Z490.1 standard asks about the content developer’s qualifications, but the company cannot supply relevant credentials, then additional information might be required to accept the training.

**COPS:** How can trainers and developers of training materials best make use of Z490.1?

**Smith:** They should use it to check their development and delivery process. Have they captured the audience’s needs? Does the developer or a member of the development team have knowledge of the subject? Many dedicated professionals created the standard, and it is an excellent reminder of what must be in an effective program.

**COPS:** Are the Z390.1 and Z490.1 standards cited in conjunction with each other? How can SH&E professionals synergize the two standards?

**Perry:** The standards do not cite or make any reference to the other. However, SH&E professionals should take that extra step to ensure that their own H₂S training course follows the training guidelines found in Z490.1. Too often, an H₂S training event is comprised of a single video followed by a short written exam. Such training discards our profession and fails to meet minimum training criteria found in Z390.1.

By first performing a training needs assessment, developing learning objectives and a comprehensive H₂S course outline in accordance with Z390.1 and by paying close attention to delivery methods and training evaluation, the new course would come more closely to meeting both Z390 and Z490 criteria, and would provide a more thorough and satisfactory H₂S training event.

**COPS:** Both standards discuss new and expanding technologies. What are your thoughts on this? For example, do you believe online H₂S training may be more effective than instructor-led training?

**Perry:** For the Z390 committee, computer-based training (CBT) was a hot topic during the last review period in 2006. We felt we needed to recognize that CBT was an innovative means of training.

However, we also cautioned that for a training event as critical as H₂S training, CBT sessions needed to be supplemented with a qualified trainer in real time. We felt that H₂S training did not lend itself strictly to CBT and that instructor-led training was more appropriate.

**COPS:** What do you believe are good recordkeeping best practices with respect to Z390.1 and Z490.1? Is electronic recordkeeping sufficient or should hardcopy documents also be retained? How do recordkeeping requirements differ between Z390.1 and Z490.1?

**Perry:** I prefer electronic recordkeeping but only as long as those records can be retrieved quickly. The volume of hardcopy training records can be tremendous, particularly with a 3- to 5-year retention. Trying to maintain training records from multiple worksites spread over several states only magnifies recordkeeping headaches.

The Z390.1 standard requires that the training outline and class documentation be retained for 3 years. The student’s employer, if different from the instructor’s, is recommended to retain a copy of those same materials for a 3-year period.

The Z490.1 standard does not specify a retention time but states that such time may be mandated by regulation, company policy or both.

Z490.1 also requires that training records include the development documents regarding the target audience, learning objectives, all training materials developed for the course, plans for evaluation and continuing improvement of the course. Further, the records should include delivery records for each training event and evaluation records.