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Hydrogen Sulfide, the ANSI/ASSE Z390.1-2006 Standard and the Impact of the Latest Revisions

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Introduction

It appears that hydrogen sulfide, or H_2S, is here for the long haul. This deadly gas has been around for centuries before you and I ever arrived and it will most likely be here long after we're gone. We have learned to regard H_2S with cautious respect, and we are able to work in H_2S-contaminated atmospheres as long as we adhere to specific safe work practices.

To refresh our memory bank about hydrogen sulfide, this gas most often occurs naturally and is a product of putrefaction or decay of organic materials. It frequently is an undesirable constituent of our oil and gas exploration and refining operations.

The gas itself has a disagreeable odor similar to that of rotten eggs at concentrations below 1 part per million (ppm). Continued exposure to H_2S without proper protective equipment will produce a temporary loss of the sense of smell at concentrations above 100 ppm in 3 to 5 minutes. Concentrations above about 500 ppm will render you unconscious almost immediately, and death will soon follow if you are not immediately removed to fresh air and revived. At concentrations above 1000 ppm, one breath is all that it takes to kill you in an instant.

The gas is about 20% heavier than air and will accumulate and concentrate in low-lying places and confined spaces. An uncontrolled flow of a seemingly-safe level of H_2S below the threshold limit value (TLV) of 10 ppm has the ability to displace air and create a toxic environment within a very short period of time. As diligent as we are in our efforts to provide a safe working environment, we still continue to lose a significant number of workers to this deadly gas every year. In fact, it is the leading cause of industrial sudden death syndrome. Hydrogen sulfide is a treacherous gas and is not to be trifled with. Utilizing proper engineering controls, personal protective equipment and comprehensive training can enable us to work safely within the realm of H_2S's potentially-hazardous threat.

The Standard

During the analyses of numerous hydrogen sulfide-related fatalities in the early 1980s, a common thread appeared consistent in all cases. That thread was the inconsistency of the H_2S safety training that had been conducted in those work environments:

- There were apparent deficiencies and variations in the course content and conduct;
- The length of the training events varied widely from one course provider to another;
- Some instructors, while possessing good presentation skills, failed miserably at conveying the important technical aspects related to H_2S;
- It was even possible to purchase an annual training certificate without even attending the course!

The discovery of these critical issues led this informal group of safety training professionals to make a determination of the relevant criteria that needed to be an integral part of a comprehensive hydrogen sulfide safety training program. These criteria were compared with actual H_2S release incidents for accuracy and applicability, then incorporated into the development of that training program for end users.

Essentially they now had a workable program, but needed a vehicle to enable the dissemination of the training program throughout the numerous industries that were impacted by the potential exposure to hydrogen sulfide. Their solution was to develop a train-the-trainer course to provide a cadre of instructors that would be able to train to the new program outline. The American Society of Safety Engineers (ASSE) stepped in as the initial course provider, and the three-day train-the-trainer course was well received in the sour gas community. Soon the attendees began to request a more stringent enforcement of the new H_2S training program. Their reasoning was that if we were to make this process work as intended, then we needed all course providers and trainers to stay on track with the course as designed.

The ASSE Director of Practices & Standards suggested that this informal group of safety training professionals might petition the American National Standards Institute (ANSI) for permission to write an H_2S safety training document. As a result, the Z390 ANSI Standard Committee (ASC) was chartered by ANSI on October 5, 1992, with ASSE designated as Secretariat.[1] It was a difficult road that we traveled during the development of the standard. There were a number of face-to-face meetings of the entire committee. We all postured to get our own concerns considered for inclusion in the final document. We argued the feasibility or necessity of “may, should or shall” in every paragraph. But the will of the committee as a whole prevailed; after two years, the initial draft was published for public review. The original Z390.1 was approved in 1995.

The standard saw moderate use in its infancy. The committee members did an amazing job of informing and advising the HSE community of the existence and availability of the standard. A few of the innovative and visionary leaders within the petroleum industry actually began to require that their employees be H_2S-trained in accordance with the provision of the Z390. The ASC felt that we were finally making a positive impact on our industry target groups.

As we approached mid-year, 2000, the ASC initiated the reaffirmation or revision process for the standard. The Z390 Secretariat, ASSE, attempted to re-establish contact with the previous members of the committee. We were able to re-enlist more than two dozen of the original members; the consensus was that we did, in fact, need to continue this standard. We were able to communicate the committee concerns through the membership via electronic means. What a

cost-saving methodology this turned out to be! The sum of the revisions were only "housekeeping issues" such as punctuation and typographical corrections. As we again achieved consensus, the Z390.1-1995 was submitted for public review and comment. We received approval for the reaffirmation in 2001.

The Z390.1-1995 (R2001) saw greater acceptance than its predecessor. The reason was a greater amount of publicity in trade and technical journals. The train-the-trainer sessions continued with that same emphasis on the standard; there were even sessions conducted abroad. Those also were trained to the standard. It appeared that we were seeing a wider distribution of the document. Indeed, even more leaders in the petroleum industry had endorsed our vision and were promoting the adoption of and conformance to the Z390.

The Z390 had matured over the past decade, and it was again time to explore revision and reaffirmation. The Secretariat was only able to contact about half of the original committee, but we did have several individuals that were interested in joining our effort. We realigned the committee and began the process once more. This time we had a potential external influence that would weigh heavily on our decision-making process. That influence came in the form of a proposed revision of the Threshold Limit Value – Time Weighted Average (TLV-TWA) and Threshold Limit Value – Short Term Exposure Level (TLV-STEL) for hydrogen sulfide by the American Conference of Governmental Hygienists (ACGIH).

In 2004, the ACGIH published a Notice of Intended Change for H_2S by reducing the TLV-TWA from 10 ppm to 1 ppm and the TLV-STEL from 15 ppm to 5 ppm to become effective in January 2007. There was immediate concern voiced from many fronts…"too much…too quickly." In December of 2004, the Z390 ASC wrote to the ACGIH and expressed those concerns citing weak and non-supportive data. In fact, some Z390 members commented that the exposure data cited in the proposal document could stand as support for the retention of the current guideline. The ACGIH thanked the Z390 committee for their comments, but stated that they intended to stand firm with their proposal to lower the TLVs.

As a self-preservation measure to protect the universal application of the Z390, the ASC amended the paragraph that recommended the application of the standard to "occupational settings where personnel have the potential to be exposed to concentrations of H_2S in excess of the Threshold Limit Values (TLVs)…..as established by the American Conference of Governmental Industrial Hygienists (ACGIH) in their 2005 publication entitled: *Guide to Occupational Exposure Levels."* By incorporating that specific wording, the ASC maintained the 10 ppm TLV action level for the Z390, regardless of any future action taken by the ACGIH.[2]

Impact of the Latest Revisions

The Z390.1-2006 has been reaffirmed with a number of revisions. Most of those were embodied to make the standard more user-friendly. As an example, the definitions of acute and chronic toxicity were modified to exclude any specific timeframe. The previous standard defined "***acute exposure:*** Generally, exposure to a substance for less than 24 hours." In 2006, the definition explained "***acute exposure:*** Exposures to high concentrations over a short period of time." The previous standard defined "***chronic exposure:*** Generally, exposure to a substance for a period of more than 3 months. Chronic toxicity tests are performed to assess the cumulative toxicity effects and carcinogenicity of chemicals." In 2006 that definition was revised to "***chronic exposure:***

Exposures to low concentrations over a long period of time." By removing the time stipulations, the ASC removed the possible question of "What happens between 24 hours and 3 months?" Further discussion of sub-acute and sub-chronic exposures were not deemed relevant for purposes of this standard.

During most train-the-trainer classes, as well as end user training, the topic of physical and chemical properties of H_2S touches on the definition of *flash point.* The definition states that the flash point is the temperature at which a liquid gives off a volatile vapor which, when mixed with air, will burn when it comes in contact with a source of ignition. For H_2S that value is -76.4^o F. The 2001 version of the standard used that definition to define ***Boiling point***. The 2006 standard changed the terminology to ***Flash Point*** to be consistent with the numerous audio/visual resources that use that same term.

Regarding personal protective equipment for use in hazardous atmospheres, the earlier versions of the Z390 all referred to "respiratory protection training, as recommended by ANSI Standard Z88.21991 (sic) Practices for Respiratory Protection." The ASC felt that this specific training issue needed to be referenced to the 29CFR 1910.134 as amended in 1998.

One of the more welcome revisions was the section on H_2S release dispersion models. Historically this has been one of the most tedious sections to attempt to convey to the end-user population. There seemed no easy way to get the concept into their way of thinking. The ASC slightly modified the wording to "If applicable, students may be apprised that dispersion models…." This change gave the trainers the flexibility to decide if their class even needed to be concerned with dispersion models in the first place. Following that thought, the training outline would slightly touch on how these H_2S release dispersion models are generated and by whom, then how they would impact the end users in the event of an emergency evacuation.

The potentially-serious consequences of chronic exposure to hydrogen sulfide gas were highlighted in the new standard. Concerns about the delayed physiological effects that manifested themselves at a later date were listed as: pulmonary edema, dizziness, photophobia, and nausea. It was suggested that hyperbaric oxygen therapy may be recommended by attending physicians to prevent these serious medical conditions.

Hydrogen sulfide instructors were previously advised that "no course should ever be abbreviated in the interest of time of any other factors." The original intent was to hopefully provide some leverage for the instructors to receive an adequate block of time for their training event. In the revision, the ASC felt that language was too forceful, and it was removed from the new standard.

Regarding course documentation and end-user certification cards, the previous standards indicated that to instructors that "a certification card *should be provided* to include…" In the newly revised standard, that language was amended to "a certification card *may be provided* to include…" This change seems to facilitate the absence of certification cards being issued to students receiving only familiarization or basic orientation classes as opposed to the complete H_2S annual safety training courses.

A final revision was the inclusion of a statement relating to computer-based training (CBT). This issue was addressed in Appendix B of all versions of the standard. However, the ASC recognized the growth of CBT in the HSE training environment and felt that it was important to make a

stronger statement in the revision. The general tone of the statement is that CBT is recognized as a valid training technique. CBT should always be supplemented with an opportunity for students to discuss their concerns and issues with a qualified trainer. An enthusiastic training event will spawn thoughtful and revealing questions from the attendees. That questioning process must be fostered for the benefit of the entire class.

Conclusion

The new Z390 is anticipated to be a more user-friendly standard. Hopefully, it will encourage affected companies and individual safety trainers to infuse their current hydrogen sulfide safety training programs with newborn enthusiasm. Comprehensive training by competent trainers is a major factor in preventing the continuation of dangerous work practices in hazardous atmospheres that may be caused by mediocre or deficient training.

Life is too precious for us to choose not to do the right thing. Excuses such as: "Business is too good to stop," or "We're shorthanded and working unreasonably long shifts to do the proper training," or "We'll get to it when we have some slack time," are unconscionable. The tool kit for the proper training has been assembled for our use. It's up to us to make those good business decisions to use those tools to our best advantage. Training is a marvelous opportunity to engage our students in the learning process, to motivate and encourage our instructors, and to eventually create a safer working environment in hydrogen sulfide-contaminated atmospheres. Don't let this opportunity pass you by!

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[1] American Society of Safety Engineers (ASSE), 1800 E. Oakton St., Des Plaines, IL 60018-2187
ANSI Z390.1-2006 Secretariat

[2] To express your concerns about the proposed TLV reduction, contact the American Conference of Industrial Hygienists (ACGIH); c/o H2S TLV Comments; 1330 Kemper Meadow Drive; Cincinnati, OH 45240 **not later than July 31, 2007**