

## Using History to Teach Hazard Communication (HAZCOM): The Halifax Explosion

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### ABSTRACT

The purpose of the Occupational Safety and Health Administration's (OSHA's) Hazard Communication (HAZCOM) Standard is to ensure that the hazards of all chemicals produced or imported are evaluated and that information is transmitted to employers and employees. This transmittal of information is to be accomplished by means of a comprehensive hazard communication program consisting of container labeling and other warnings, material safety data sheets, and employee training. Unfortunately, HAZCOM is often ranked fairly high on OSHA's "top 10 list" of violations. The violations typically result from either neglecting to have a written HAZCOM program or failing to provide information and training on hazardous chemicals. Specifically, enhancements are needed to provide training that combines training effectiveness with the three primary learning styles: visual (seeing), auditory (hearing) and kinesthetic/tactile (learning by doing). Although training-by-video captures approximately 95% of the population's primary learning styles, the key to effective training, however, is that it must create genuine interest and motivation for students to make use of the presented information. In this specific application, there is a desire to provide HAZCOM training in practical terms and concepts, such that the employees are capable of responding to situations in the field and have a heightened awareness of the unfortunate events that can occur when this information is disregarded. This paper documents how WESKEM, LLC's Environmental, Safety and Health (ES&H) Department enhanced its HAZCOM training program by incorporating "non-traditional videos", such as the Halifax Explosion, one of the largest ever non-nuclear, man-made explosions, that occurred in 1917. This maritime event serves as an excellent educational tool demonstrating how one single event can become life threatening when failing to either train employees effectively or disseminate available information (i.e., HAZCOM).

### INTRODUCTION

According to the Occupational Safety and Health Administration (OSHA), over 30 million American workers are exposed to hazardous chemicals in their workplaces (1). Therefore, the "Purpose" of OSHA's Hazard Communication Standard (HCS), as defined in Title 29 of the Code of Federal Regulations, Part 1910.1200(a)(1) [29 CFR Part 1910.1200(a)(1)], is to:

*"...ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container*

*labeling and other forms of warning, material safety data sheets and employee training.” (2)*

Since the HCS was promulgated 20 years ago, the availability of chemical information in the work environment has increased dramatically, whereby businesses rely on product labels, Material Safety Data Sheets (MSDSs), and web sites as primary sources of chemical information. The HCS covers some 650,000 hazardous chemical products found in over three million establishments.

## **APPLICABILITY OF THE HCS TO WASTE MANAGEMENT**

Although the HCS applies to pure products supplied by vendors, the application of this regulation is useful for hazardous, radioactive and mixed waste planning purposes. For example, hazardous, radioactive and mixed waste streams are typically comprised of a myriad of individual solid or liquid hazardous, radioactive and mixed waste chemicals. Nitric acid, either by itself or as part of a combined waste stream, is still nitric acid. Therefore, the MSDS for nitric acid can be used to assess safety issues (e.g., personal protective equipment, first aid measures) associated with handling this particular component of the waste stream to prevent employee exposure.

## **AN EMPLOYER'S HAZCOM TRAINING PROGRAM**

Employees are to be trained at the time they are assigned to work with hazardous chemicals. However, the HCS training provisions are not satisfied solely by having the employee read the product labels and/or MSDSs. An employer's HAZCOM training program is to be a forum for explaining to employees not only the hazards of the chemicals in their work area, but also how to use the information generated from their hazard communication program.

In accordance with the HCS, 29 CFR Part 1910.1200(h), "*Employee information and training*", 29 CFR Part 1910.1200(h)(1) states that:

*“Employers shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new physical or health hazard the employees have not previously been trained about is introduced into their work area. Information and training may be designed to cover categories of hazards (e.g., flammability, carcinogenicity) or specific chemicals. Chemical-specific information must always be available through labels and material safety data sheets.” (2)*

The following HCS sections provide specific details on employee information and training:

*1910.1200(h)(2) - "Information." Employees shall be informed of:*

*1910.1200(h)(2)(i) - The requirements of this section;*

*1910.1200(h)(2)(ii) - Any operations in their work area where hazardous chemicals are present; and,*

*1910.1200(h)(2)(iii) - The location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and material safety data sheets required by this section.*

*1910.1200(h)(3) - "Training." Employee training shall include at least:*

*1910.1200(h)(3)(i) - Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);*

*1910.1200(h)(3)(ii) - The physical and health hazards of the chemicals in the work area;*

*1910.1200(h)(3)(iii) - The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used; and,*

*1910.1200(h)(3)(iv) - The details of the hazard communication program developed by the employer, including an explanation of the labeling system and the material safety data sheet, and how employees can obtain and use the appropriate hazard information.*

Part 1910.1200(h), "Employee information and training" is already a part of WESKEM, LLC's work planning process that incorporates the Department of Energy's Integrated Safety Management System (ISMS). The methods used by WESKEM, LLC to incorporate work planning and ISMS are discussed elsewhere (3-5).

## **THE "TOP 10 LIST" OF OSHA VIOLATIONS**

Despite the availability of chemical-specific information from company web sites, HAZCOM continues to appear on the "top 10 list" of OSHA violations. In Fiscal Year 2003 (FY2003), HAZCOM ranked 2<sup>nd</sup> with 6,800 violations. In FY2004, which ran from October 1, 2003, through September 30, 2004, HAZCOM ranked 2<sup>nd</sup> again with 7,318 violations. The top five sections cited by OSHA consisted of the following:

*1910.1200 (e)(1) — Failure to develop and maintain a written program (2,319 or 32%),*

*1910.1200 (h)(1) — Failure to maintain training (1,044, or 14%),*

*1910.1200 (h) — Lack of employee training (768 or 10%),*

*1910.1200 (g)(1) — Failure to have a Material Safety Data Sheet for each hazardous chemical (707 or 10%),*

*1910.1200 (f)(5)(i) — Failure to label each container with the identity of the hazardous chemical within (590 or 8%).*

Regarding willful violations, defined as one "...committed with an intentional disregard of or plain indifference to the requirements of the Occupational Safety and Health Act and regulations", HAZCOM was ranked 10<sup>th</sup> with approximately 4%, or 14 of the 364 total number of violations. Under serious violations, defined as "...one in which there is substantial probability that death or serious physical harm could result, and the employer knew or should have known of the hazard", HAZCOM ranked 3<sup>rd</sup> with approximately 11%, or 3,707 of the 33,603 total number of violations (6). From October 1, 2004 through August 30, 2005, the

second most-cited standard remains HAZCOM with approximately 16%, or 6,641 of the 40,463 total number of violations (7).

## **ANNUAL HAZCOM INFORMATION AND TRAINING**

WESKEM, LLC provides HAZCOM training to all its employees and subcontractors annually. To address the variety of considerations required to provide effective HAZCOM training (e.g., formal classroom training, field applications, etc.), Table I. summarizes the HAZCOM training information that is disseminated to all employees:

Table I: HAZCOM Training Information

• Reason for a HAZCOM Plan
• The HCS and the standard operating procedure that addresses HAZCOM
• Labeling, MSDS books and their importance
• Common types of materials expected to be encountered on site
• Container disposition
• Building postings and waste storage matrices
• Employee protection and responsibilities

## **TRAINING EFFECTIVENESS AND LEARNING STYLES**

Based on industry surveys evaluating training effectiveness, a majority of workers attribute only 10% of their own job proficiency to formal training courses and books. In addition, 20% of learning is affected through coaches and mentors, and 70% of learning happens informally through on-the-job and off-the-job interactions (8). Specifically, enhancements are needed to provide training that combines training effectiveness with the three primary learning styles: visual (seeing), auditory (hearing) and kinesthetic/tactile (learning by doing). One style is not used exclusively. Depending on the subject, there is usually significant overlap in learning styles (9).

### **Visual Learners**

Visual learners relate most effectively to written information, notes, diagrams and pictures. Information does not exist for a visual learner unless it has been written down. This is why some visual learners will take notes even when they have printed course notes on the desk in front of them. Visual learners, approximately 65% of the population, tend to be most effective in written communication and symbol manipulation.

### **Auditory Learners**

Auditory learners relate most effectively to the spoken word. They will tend to listen to a lecture, and then take notes afterwards. Information written down will have little meaning until it has been heard, and it may even help auditory learners to read written information out loud. Auditory learners, for example, may be sophisticated speakers and may specialize in subjects like law or politics. Auditory learners make up about 30% of the population.

## **Kinesthetic/Tactile Learners**

Kinesthetic/tactile learners acquire knowledge through touch, movement and space. They learn skills by imitation and practice and make up around 5% of the population.

## **HAZCOM AND HISTORY: THE HALIFAX EXPLOSION**

Training-by-video is a common industry practice that can be applied to a variety of subject areas and topics. Also, training-by-video captures approximately 95% of the population's primary learning styles. Furthermore, a simultaneous source of audio and video increases audience retention of information by as much as 50% over printed material. The key to effective training, however, is that it must create genuine interest and motivation for students to make use of the presented information. In this specific application, there is a desire to provide HAZCOM training in practical terms and concepts, such that the employees are capable of responding to situations in the field and have a heightened awareness of the unfortunate events that can occur when this information is disregarded. This paper documents how WESKEM, LLC's Environmental, Safety and Health (ES&H) Department enhanced its HAZCOM training program, as well as other training programs and monthly safety meetings, by incorporating "non-traditional videos", such as the Halifax Explosion that occurred in 1917 (10).

Halifax Harbor in Nova Scotia, Canada, was busier than usual, teeming with ships whose schedules were dictated by the commerce of World War I (WWI). The Harbor served as a gathering point for ships being escorted by convoy to Europe, which was in the midst of WWI.

On December 5th, the French ammunition ship *Mont Blanc* was shipping large quantities of munitions to Bordeaux, France, and was waiting to enter the Harbor for a planned anchorage in Bedford Basin. Table II. lists the cargo of the *Mont Blanc*:

Table II: Cargo of the *Mont Blanc*

• 4.5 t (5 short tons) of benzol
• 300 rounds of ammunition
• 56 t (122,960 pounds) of gun cotton
• 2,090 t (4,600,000 pounds) of picric acid (explosive)
• 2,115 t (4,661,794 pounds) of trinitrotoluene (TNT)

The Belgian relief ship, *Imo*, that was once a passenger ship for the White Star Line, was on its way to New York to pick up relief materials for Belgium. Since this was during WWI, submarine nets were used as a precaution to stop enemy U-boats, as well as prevent other ship traffic from navigating the Harbor at night. Both ships had arrived late that day and would have to wait until the next day, December 6, before proceeding on their intended voyage.

On the morning of Tuesday, December 6, 1917, local pilots were assigned to each ship to ensure a safe passage through the harbor. However, the pilot assigned to the *Mont Blanc* spoke English and the crew spoke only French.

The *Imo* was going to proceed in the right channel, but another ship was blocking its path, so it went to the left channel. The *Imo* blew its whistle two times to tell the *Mont Blanc* of its predicament, and an order was given to the crew to change course by the pilot that, unfortunately, was not understood by the crew.

The *Mont Blanc* was proceeding forward via the left channel at the same time, and both ships refused to yield. Finally, the *Mont Blanc* decided to pass the *Imo* and go into the center. The *Imo* then stopped altogether, but the backward action of the propellers brought the *Imo* to the center of the channel as well, turning its bow straight in the direction of the *Mont Blanc*. Both ships collided in the narrows of Halifax Harbor around 8:45 a.m. The *Imo*'s bow ripped a hole at least 3 meters (10 feet) into the hull of the *Mont Blanc*. The *Imo* then tried to pull back. Sparks from the metal-on-metal collision ignited the vapors from the benzol stored on the deck setting the *Mont Blanc* on fire.

A large cloud of black smoke rose 100 meters (328 feet) into the air. The *Mont Blanc* burned for ten minutes before the first alarm was sounded. As the fire spread, it blocked the crew from reaching fire-fighting equipment. Following the captain's orders, the crew quickly abandoned ship.

Fleeing in two rowboats, the French-speaking crew reached safety on the English-speaking Dartmouth shore as the burning ship continued to drift toward the Richmond Pier on the Halifax shore. Because of the language differences, the crew was unable to warn the residents of the impending disaster. Hundreds watched the burning ship from the shoreline and from windows in neighboring houses.

The resulting explosion occurred at 9:04:35 a.m., making it one of the worst maritime disasters in history. It still ranks as one of the largest ever non-nuclear, man-made explosions, equivalent to a 2.5-3 kiloton nuclear detonation. The *Mont Blanc* was instantly fragmented, with much of it vaporizing into a giant fireball that rose over a kilometer (mile) into the air, casting its anchor several kilometers (miles) away. Shards of glass and other debris maimed and killed many in Halifax and Dartmouth. Also, a 4.5-meter (15-foot) wave shot out from the explosion wrecking ships, and flattening anything left standing following the explosion. Many survivors depicted the scene as though the Narrows opened up to reveal the harbor floor.

One of the most noted heroes of the day was Vince Coleman, who abandoned his chance to survive by returning to his telegraph office to warn two Intercolonial Railway passenger trains bound for the North Street station of the impending danger. Although he was killed in the blast, the trains received the warning and stopped on the city's outskirts in Rockingham, escaping harm in the explosion and then relaying the message to summon outside help.

The explosion leveled over 2.5 square kilometers (km<sup>2</sup>) (1 square mile) of Halifax. Windows were shattered as far as Truro, Nova Scotia, located 100 kilometers (62 miles) away. The blast could be heard as far away as Prince Edward Island. The disaster resulted in approximately 2,000 dead, 9,000 injured, 25,000 homeless and, according to one conservative estimate, roughly 30 million (1917 dollars) in damage. The following day a blizzard hit the city, crippling recovery efforts.

## **REGULATORY AND PRACTICAL APPLICATIONS OF HAZCOM**

The regulatory application of HAZCOM is to ensure that the hazards of chemicals are evaluated and information concerning their hazards is transmitted to employers and employees. This transmittal of information can be accomplished by means of a comprehensive hazard communication program that consists of container labeling and other forms of warning, material safety data sheets and employee training.

The practical application and understanding of HAZCOM is valued when it is applied to events in history, as in this case, the Halifax Explosion. Although hindsight is 20/20, it is still difficult to say whether our current understanding of HAZCOM could have prevented the explosion. The *Imo*, although a non-factor as far as the blast was concerned, ignited the initial fire. Also, the *Imo* was traveling faster than was customary in the Narrows and was out of its correct lane. On the other hand, the *Mont Blanc* was a floating arsenal and was not flying the red pennant that was the internationally recognized symbol of having explosives on board a ship. The captain of the *Mont Blanc*, for his part, contended that the red pennant was customary, but not mandatory. He stated that it would have been suicide for a vessel to fly the pennant in wartime, especially one as slow as the *Mont Blanc* with her top speed of 4 meters per second (7.5 knots). Official inquiries would later identify an inadequate supply of harbor pilots, language problems, and ignoring harbor safety guidelines as contributing factors to the explosion.

## **CONCLUSION**

In preparing the HCS, OSHA examined industry programs to take advantage of good industrial practices. As a result, a 3-pronged approach was developed when implementing the HCS: 1) container labeling and warnings, 2) MSDSs, and 3) employee training for those employees exposed to hazardous chemicals in order to reinforce the information presented on container labels and MSDSs. This training can be accomplished in many ways (e.g., classroom instruction, interactive videos) and should provide opportunities for employees to ask questions to ensure that they understand the information presented to them in concert with the appropriate style of learning, and how employees learn to retain and understand the presented information. Specifically, the use of videos can be a cost-effective and time-efficient method for training employees, regardless of company size and complexity.

The annual WESKEM, LLC HAZCOM training program consists of classroom instruction, a hands-on review of labeling requirements, a “question and answer” session, and incorporating lessons learned from the Halifax Explosion. This approach addresses all three learning styles (9) thereby ensuring that WESKEM, LLC employees can apply HAZCOM in practical terms and concepts. Furthermore, this historical event, captured in video and classified as one of the more noteworthy disasters of the twentieth century, serves as an excellent educational tool demonstrating how one single event can become life threatening when failing to either train employees effectively or disseminate available information (i.e., HAZCOM).

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