The Effect of Chemical Incidents on First Responders:

An Interview with Bruce Evans (MPA, NRP, CFOD, SEMSO), Fire Chief, Upper Pine River Fire Protection District

A massive leak of liquefied chlorine gas created a dangerous cloud over the city of Henderson, NV, in the early morning hours of May 6, 1991. Over 200 people (including firefighters) were examined at a local hospital for respiratory distress caused by inhalation of the chlorine and approximately 30 were admitted for treatment. Approximately 700 individuals were taken to shelters, and between 2,000 and 7,000 individuals were evacuated from the area. ASPR TRACIE interviewed Chief Bruce Evans (who was a firefighter-paramedic at the time of the incident), asking him to share his experiences and highlight how the fire and emergency response to chemical incidents has changed over the years.

Corina Solé Brito, ASPR TRACIE (CSB): Can you please share your experience in Henderson and other related incidents, how you think the field has changed since then, and what you think the future holds?

Bruce Evans (BE): I am fortunate to have lived through two major incidents that have culminated in U.S. Fire Administration technical reports. When I was 21, I left Central Iowa to be a paramedic in Las Vegas in 1985. Just a few years later, I was involved in my first large-scale incident: the PEPCON explosion. PEPCON was a rocket fuel plant that supplied propellant used for the space shuttle program. This explosion sent a shock wave over the entire Las Vegas Valley, blew out windows that were miles away, and created a small, multicolored mushroom cloud on the south end of the valley. The Professional Golfers' Association (PGA) was also in town, so there were satellite trucks and news trucks present. At that time, the rudimentary cell phone network was overwhelmed very quickly; this was my first experience with not being able to communicate with a supervisor. I didn't know what chemicals were in that cloud, or how many fatalities or injuries from flying debris were to be expected. The hospital—a small, critical access hospital at the time—became overwhelmed with the walking wounded. That was a "chaos event," and the type that most large departments hadn't

Access these U.S. Fire Administration Technical Reports for more information on these incidents:

- Fire and Explosions at Rocket Fuel Plant
- Massive Leak of Liquefied Chlorine Gas

dealt with. At the time, Henderson Fire Department did not have paramedics as part of their team—after this incident, they decided to increase their level of care, and I was recruited to serve on that fire department.

Fast forward to 1991, when the largest leak of liquefied chlorine in U.S. history took place, also in the Las Vegas suburbs, at the Pioneer Chlor Alkali Company. Late that night, we (Henderson Fire) got a call to assist some firefighters from Clark County Fire Department who were at the company's gate. Our two communications centers ultimately decided that Clark County should respond first, since the facility—while it was essentially an "island" surrounded by the residential area of Henderson—was technically in the county's jurisdiction. At first, people were only reporting a strong smell of chlorine, so members of the first engine company, an ambulance, and a battalion chief vehicle pulled up to the gate without their air packs on. One of the captains later said he thought it was odd that the security personnel in the guard shack were wearing gas masks.

Pioneer Chlor Alkali was storing liquefied chlorine in tanks, and after crews had serviced the tanks, they had left some water in an elbow area of a pipe. When they recharged the tanks, the chlorine mixed with the water and basically formed almost pure hydrochloric acid, which burned right through the pipe. Because it was at an elbow, at a 90-degree angle, you couldn't get a patch on it. Nearly 90 tons of liquid chlorine spilled, then aerosolized at more than 300 times its volume.

As soon as the Clark County firefighters got out of the firetruck, they were immersed in and overcome by a cloud of extremely high parts per million of chlorine. Chlorine is a respiratory irritant that can cause non-cardiogenic pulmonary edema, and when it mixes with moisture—either in your airway or areas where

you might be sweating, like your armpits or groin—it turns into hydrochloric acid and burns what it comes in contact with. When we arrived (wearing our air packs), we rescued eight people; as a firefighter-paramedic at the time, I remember very vividly seeing the battalion chief coughing up blood. Everyone had mucus running out of their eyes and noses, and their eyes were burning. We tried to decontaminate them as quickly as possible and get them to the hospital for treatment.

We returned to the command post, and this is when I learned a specific lesson. A command officer showed up and started making some questionable decisions that ultimately lead to the injury of more firefighters. The officer chose to send a few firefighters into the facility in a pickup truck to try to put a patch on the leaking container. The two members from the HAZMAT team were allowed to don Level B protection suits (Tyvek and an air pack). In this day and age, I would never let anyone go into a situation like that without a Level A suit.

When these two firefighters returned about 15 minutes later, jumped out of the truck, and started stripping off their clothes, I remember seeing how the chlorine had penetrated through their Tyvek suits. Most firefighters wear a navy blue t-shirt and navy blue pants. The chlorine had seeped through the Tyvek suits and bleached their shirts, turning them pink where the zippers were. It is extremely warm in those suits, and you essentially create your own humidity when you wear one. The gas reacted with the sweat in their armpits and groin areas, burning any skin that had perspiration on it. We had to strip them down and perform a field decontamination (i.e., rinse them with the fire hose) and transport them to the hospital.

We came back to the command post a second time, and I learned another lesson. The plant official, the expert on chlorine, arrived and told us we were too close to the spill and instructed us to move further away. I remember listening to him advise the incident commander, who replied, “Well, chlorine is heavier than air; it should travel downhill and we should be safe here.” About 20 minutes later, the cloud was so large that it overtook the command post and we had to evacuate and very hastily move to another staging area. Just 10 minutes later, the cloud grew even larger and overtook us again. We rescued four more firefighters who had been overcome by the fumes, and once again, the scene became chaotic.

At that point, I decided to take the four injured firefighters to another hospital farther away from the primary access hospital that we normally use. After we dropped them off, we sat in our truck and listened to the radio, waiting for someone to gain control over the scene. About an hour later, we heard that there was a strong incident commander in place, making good decisions, so we returned to the scene. Overall, we sent about 45 firefighters to the hospital.

Once the sun came up and the heat dissipated the chlorine, you could see this massive, green cloud sitting over most of the (evacuated) community. Within a couple of days, all of the trees were completely defoliated. Once the incident was deemed complete, the crews that performed most of the rescues reported to the hospital to be checked out. We realized the chlorine had off-gassed from patients and some of the firefighting equipment and actually pitted the stainless steel in the back of our ambulances.

Even though we wore our air packs while we treated patients in the ambulances, we all got a fairly significant dose of chlorine. The hospital that we went to had a TOMES database and they also called Poison Control, explaining that they were treating firefighters who had inhaled chlorine gas. At that time, the TOMES database and the Poison Control operator told the physicians to nebulize bicarbonate. We all sat in the emergency room (ER) with nebulizers, inhaling bicarbonate solutions.

This was not the correct treatment plan. Simple chemistry shows that when you mix an acid in a base, it is going to give off heat, creating an exothermic reaction. So as we inhaled that nebulizer bicarbonate based on the directions given to the ER doctors by the Poison Control center, we all wound up with low-level respiratory burns. Most of us ended up with reactive airway disease, and it was probably seven or eight years before I could get my lung capacity up to where I could stop using an inhaler. One of my colleagues who had an underlying asthma condition was off work for almost two years, in a worker's compensation situation, while trying to get his lung capacity to the point where he could wear an air pack again.

The National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) later came in and highlighted the errors that were made and made recommendations for future work. Based on these results, and to reduce the pending fines (levied based on a NIOSH investigation into prior training, equipment provided, and other related factors), the International Association of Firefighters sent a team in from Phoenix and trained everyone in the department up to the HAZMAT operations level under the NFPA Standards 472 and 473, and covered how to operate in a Level A suit and perform decontamination. Additional research on our part found that the treatment protocol in the TOMES database used by the Poison Control operator at the time was based on one study conducted on only eight patients. Based on the lessons we have learned from other incidents over the years and the advancement of HAZMAT medicine, the guidance has changed significantly.

After that incident, I wanted to have the knowledge to be able to politely refuse an order or point out to an incident commander that their instructions might be unnecessarily putting people at risk. In 1994, the National Fire Academy began offering a new class called "Advanced Life Support Response to Hazardous Materials Incidents." Instructors taught one week of organic and inorganic chemistry followed by another week of toxicology. I took the inaugural course and I've been on the instructor cadre for this class for 20 years.

Subsequently, I had a long conversation with the director of the local Poison Control center, and we agreed they would look into their protocols and update them based on this experience. Now they know to use normal saline to dilute and stabilize the chlorine.

CSB: You said your health effects lasted 7-8 years. Can you share more about the health effects for other firefighters who responded to this incident?

BE: A lot of people who were injured were lucky enough to be moved into administrative and training positions. Ultimately, everyone returned to work. The battalion chief I mentioned earlier who was in non-cardiogenic pulmonary edema returned for about six months and then retired. After nearly two years, the firefighter-paramedic who had an underlying asthma condition returned to work and was able to finish his career.

CSB: Did the event overwhelm the healthcare facilities? Was the hospital evacuated?

BE: This event absolutely overwhelmed the small community hospital located a quarter of a mile from the facility. Not only did we flood that facility with patients, but it was located downwind from the leak. If this were to happen now, we would evacuate the hospital, but it remained operational throughout the event. We had done shelter-in-place drills with the local schools, where they would shut down their HVAC systems, duct tape classroom doors, and put plastic sheeting around the entrances to the buildings. The schools were much more prepared than the hospital was for dealing with a chemical leak. I don't think zoning permits would allow a chemical facility like that to be built anywhere near a residential area today.

Of course today, hospitals are required to go through these types of drills. And when the hospital was remodeled several years ago, they incorporated lessons learned from the incident and added outside decontamination facilities close to the ambulance entrance and built double-door systems to enable them to isolate the ER. The Joint Commission has done a fantastic job encouraging hospital preparedness. With ASPR's help and after 9/11, hospital administrators understand that self-evacuated patients—some who may be contaminated with chemical or weaponized materials—can show up at the ER without any EMS involvement, and are preparing for these scenarios.

CSB: What else "keeps you up at night?"

BE: There is a human condition, or a protective factor, that makes us feel like things can't ever be that terrible, that terrible incidents like this can't happen. While we don't want to believe that humans can cause other humans harm, I feel like we still must focus on and prepare for the worst case scenario. We can learn a lot from the Israelis who unfortunately have vast experience in these types of incidents. EMS providers in Israel generally are allowed to take their vehicles home with them, allowing them to quickly respond in a vehicle that can transport a patient. In the article Health and Medical Response to Active Shooter and Bombing Events, we discuss the benefit of pre-designed response matrices which are programmed to assign a set of resources to specific incidents.

On a related note, I think one of the things we are losing sight of in traditional medicine is the "rule out." For a long time, physicians were taught to start by assuming the worst case scenario to cover all of their bases. This is being lost now, when providers are being pushed to stick to time-related metrics and make quick treatment decisions.

CSB: Do you have any final thoughts to share with our readers?

BE: After 9/11, first responders were supposed to be trained to the HAZMAT operations level, because the awareness level doesn't include the decontamination piece. But so many departments still only train to the awareness level and this is a challenge with private ambulances serving about 40% of the country. All of our ambulances at Upper Pine contain one five gallon bucket that holds two Tyvek (Level B) suits that can be paired with self-contained breathing apparatus to function as Level B equipment, an adapter hose, dish soap, and gloves—if responders encounter something in the field, they can quickly decontaminate.

Chemicals are evolving. Look at organophosphates, look at fentanyl. Bad actors involved with "street chemistry" are getting "better" at what they do. Including the basics of chemical awareness and response in continuing education programs can both increase responder resilience and readiness for the next asymmetrical incident. ■